MACHINERY.

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CONCRETE FOUNDATIONS.

PRACTICAL HINTS FOR BUILDERS OF MACHINERY FOUNDATIONS.

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From time to time during the past few years there have appeared in the columns of the technical press, articles pertaining to foundations and methods of anchoring machinery to them. Several years ago I assumed my first responsible position and a few months later was called upon to put down foundations and set up machinery amounting to some $20,000. The drawings were from the office of a consulting engineer and were "non-committal," to say the least. I was certainly "up against it." I seached my file of papers for the articles referred to, but when found they told me next to nothing of the nature and qualities of cement, lime, sand, stone or brick. A little book on "Foundations" was purchased but proved to be an exposition of the foundations of immense structures, those of the East River bridge occupying a large share of the book. I did not know, at that time, that the information I was in search of was contained in text books and papers on civil engineering; as it was, I just went ahead on my nerve and, as good luck would have it, I came out all right.

What I want to do in this paper is to tell a few of the things I have found out since that time—things that one is supposed to know but which a great many do not know.

The possibilities of concrete are almost without limit and one of its most "useful uses," is for the foundations of machinery. For both footings and piers it far surpasses either brick or rubble, both in excellence and cheapness. Concrete is, of course, composed of sand, broken stone or gravel, and cement; the proportions varying for different grades of material and classes of work. Sand is formed by the disintegration of various rocks and, like them, may be divided into three general classes: calcareous, silicious and argillaceous. The calcareous sands are those arising from lime-bearing rocks and while rare, are valuable for both mortar and concrete. The silicious sands are composed of quartz or feldspar and are the most common and valuable. The argillaceous sands are the clayey sands and are worthless for our purpose. Builders classify sand according to the size of the grain. When the grains run from 1-16 inch to ⅛ inch in diameter it is called coarse sand; while between 1-24 inch and 1-16 inch it is called fine sand. Any mixture of these two grades is called mixed sand.

Bank or pit sand is considered the best for concrete work as the grains are more angular and sharp than those of river sand. Under a microscope good sand will show a sharp and irregular appearance.

Bank and pit sand, is, however, apt to be mixed with clay or loam, and if this is the case it must be thoroughly washed before using. This is done by placing the sand in a large box and turning a stream of water on it. The box should have cracks in the bottom between the boards to let the water out, but the cracks should not be large enough to let much sand through. Sand may be washed in the wagon or cart in which it is hauled. After washing, the sand should have an opportunity to drain before being used. Perfectly clean sand may be rubbed between the fingers without soiling them. The amount of dirt left on the fingers after such handling is a good index of the cleanliness of the sand.

Sand for concrete work should not contain more than 40 per cent. of void. To determine this percentage weigh a bucket, then fill it with water and weigh again. A simple problem in subtraction will give the weight of water contained in the bucket. The water is then emptied into another vessel and the bucket filled with damp sand. Add water to the sand until the bucket is quite full and by weighing the water that remains determine the amount of water that has been added to the sand. The amount of water added to the sand divided by the total weight of water, will give the per cent. of void in the sand.

The gravel used in this work is nearly always found in connection with the sand. The mixed sand and gravel in the bank should first be screened over a screen having a ⅜-inch mesh; what falls through should be tested for voids and, if necessary, screened again to bring the per cent. of void low enough for economical working. The gravel on top of the screen should be screened again, this time over a 1½-inch mesh screen to remove the large stones. In good gravel the stones are hard, irregular in shape, and varying in size.

Broken stone makes rather better concrete than gravel but it is more expensive. Trap or volcanic rock makes the best concrete but limestone and quartz rock are often used—especially in the middle west. The stone should be graded from ¼ inch to 1 inch in diameter.

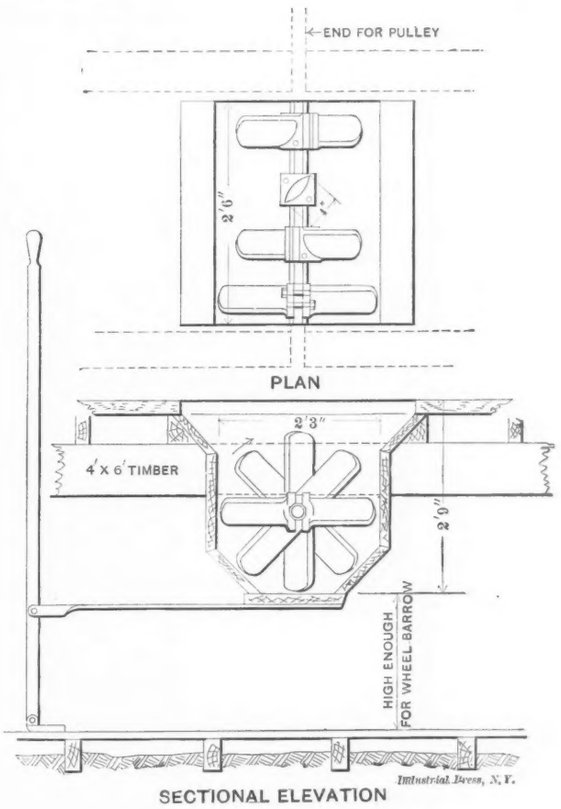

Fig. 1. Home-made Concrete Mixer.

Both gravel and broken stone should be well washed before using. This is done in a manner similar to the sand washing. In the case of broken stone the washing may be done just before using, thus avoiding the necessity of giving the stone an extra wetting; for dry stone would have a tendency to draw the water out of the concrete and should therefore be worked wet.

The cement used in concrete work should be of good quality; generally speaking the better the cement the better the concrete. Portland cement is the best and also the most expensive. If the finished work is to have considerable time to harden, a natural cement may be used. Rosendale in the east and Louisville in the west may be taken as characteristic natural cements.

As a rule the heavier cements are the best—Portland cement should weigh about 375 pounds to the barrel (net) with

Rosendale at 300 pounds and Louisville at 265 pounds per barrel.

The more finely ground the cement the better, as it is only the finest portion that has any value as cement. With Portland cement, between 90 and 92 per cent. should pass a sieve of No. 40 wire (Stubbs gage) 100 to the inch (10,000 meshes per square inch); and with natural cement 80 per cent. should pass through the same sieve. One soon learns by the feeling of cement as it is rubbed between the fingers, whether it is finely ground or not.

Natural cement should not take its first set in less than 10 minutes and should not require more than six hours for its final set. The term "first set" may be determined by a pat of neat cement supporting without indentation a ¼-pound weight on a wire 1-12 inch in diameter; final set by the pat supporting a 1-pound weight on a wire 1-24 inch in diameter. Portland cement should not take its first set in less than thirty minutes and should take its final set in not more than ten hours.

To sample a lot of cement in barrels, take an auger and drill into the barrel well toward the center. Enough should be taken out to make a pat some 3 inches in diameter and ½ inch thick at the center, tapering to ⅛ inch at the edges. The cement should be mixed with just enough water to form a dough and should be worked for several minutes, then formed into the pat. A piece of glass or an old plate is the proper thing to make the pat on. This pat should be watched to determine the first set and should then be covered with a damp cloth, for about 24 hours. At the end of that time it should be placed in water (plate and all) and kept there for several days or even three or four weeks. It should show no sign of disintegration along the thin edges, and no signs of distortion, or expansion cracks. Cement in bags may be tested by selecting samples from bags, at random, and mixing them together, then taking a sample from the mixture to form the pat. Cement showing lumps should be looked upon with suspicion and tested thoroughly.

If samples of cement fail in these simple tests it should either be rejected or taken to a person competent to conduct a more rigid examination.

The sand gravel, and cement, of satisfactory quality for the work in hand being brought together, the proportions for compounding next claim our attention. The ingredients should be thoroughly mixed and in such proportion as to secure economy of material and at same time to produce a substance resembling, as nearly as possible, the character of stone. The proportion of sand should be such as to fill the voids in the gravel, and the cement should just fill the voids in the sand. This is the most economical mixture obtainable. The void in ordinary sand will vary from 35 to 50 per cent.; therefore the difference in cost of concrete using the two extremes would be about as 4 is to 5, the difference being in favor of the sand having the less voids.

When the gravel contains 50 per cent. void, the proportion of sand to gravel will always be as 1 is to 2; with sand of 50 per cent. void the proportion of cement to sand will also be as 1 is to 2. In this case the proper proportion would be: 1 of cement, 2 of sand and 4 of gravel. If the sand contained 33 per cent. void, the proportion would have been: 1 of cement, 3 of sand and 6 of gravel. After once testing, the proportions would, of course, remain constant for any locality.

One part Portland and 4 or 5 parts of natural cement, make a very good cement to use for ordinary work, as it is stronger than all natural cements and is only a trifle more expensive. At the end of seven days the strength of natural cement is only about ¼ that of Portland. At the end of the first month the ratio is ½, the natural cement having gained strength more rapidly. For this reason, foundations built of natural cement should not be used for at least two weeks. Foundations of concrete should be of the same size as those of brick or stone, the weight of good concrete being about the same as that of brick and somewhat greater than that of rubble, but the allowable compression is greater for good concrete than for either brick or rubble.

For the best results, the concrete should be accurately measured and thoroughly mixed. The sand and gravel may conveniently be measured in rectangular wheelbarrows (not round bottom barrows) of suitable size and the cement may be shoveled into a box or other measure, or may be purchased in bags containing about one cubic foot (¼ barrel exactly)—which makes a convenient measure. In mixing, the ingredients should be turned at least twice—once dry and once wet.

When mixing by hand I dump the ingredients together on a plank floor and then shovel onto a new pile, mixing constantly with iron rakes. The pile is then shoveled over again in the same manner except that the proper amount of water is sprinkled on, during the mixing. For hand mixing the batches should not contain more than one cubic yard. Care should be taken to be sure that the time of mixing does not exceed the time taken by the cement for its first set, as the concrete should be in the foundation and well rammed before it takes its set. The water should also be measured and should be added by sprinkling rather than by pouring it all on at once.

No proportion can be given for the amount of water required but after a few batches have been mixed, one can readily determine this quantity. The concrete should appear to be just ready to show the water—perhaps as soft as plaster. If it is too dry, there will be holes in the foundation; and if it is too wet, it cannot be rammed at all. However, it is better to be too wet than too dry.

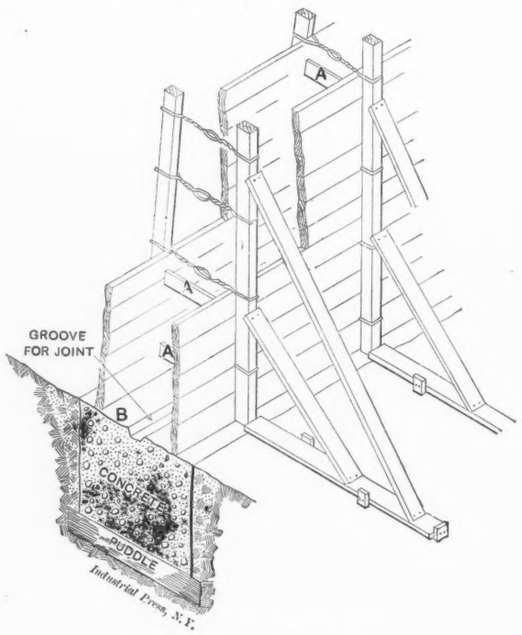

Fig. 2. Form for Concrete Work.

When putting it in, the concrete must be built up in layers of from 4 to 6 inches, and each layer thoroughly compacted by iron rammers. It is rammed sufficiently when the water comes to the top. The concrete should also be washed down along the edges of the forms with a spade to insure a neat looking job on the outside.

The best concrete is machine mixed; for with this method there is no tendency to slight this very important step. Fig. 1 is a home-made concrete mixer. The box may be made of any hard wood and is provided with a wooden or iron slide at the bottom, for removing the concrete. The revolving knives or mixers are bolted to an octagon shaft which has bearings turned on it and a pulley on one end. The speed should be about 40 revolutions per minute, and a 24-inch pulley with a 4-inch belt will drive it. The sand, gravel, cement, and water are put in from a platform, and the concrete is dumped into a wheelbarrow placed under the machine. The machine should be washed out every night after using.

I have not said anything about the forms for concrete work. Of course they must be strong, tight and smooth on the inside. Fig. 2 shows an isometric view of a form for a wall about 10 feet high. It will be noted that the wall is braced in three places, besides being wired. The wire is about No. 12 iron wire. The braces *AA* are loose, or only tacked in place, and are removed as the wall is built up. Do not nail the sheeting too securely to the studding. Any carpenter can

put these forms up and the cheap, unskilled men that wheel the concrete may be employed to assist in the bracing and sheeting. Different methods of bracing the forms will readily suggest themselves to the mechanic in charge, to conform to the local conditions. Fig. 2 shows the wall with a footing extending several inches outside it. If the ground is firm, no sheeting is required for this footing, as the concrete is merely thrown into a trench and rammed. In any case the

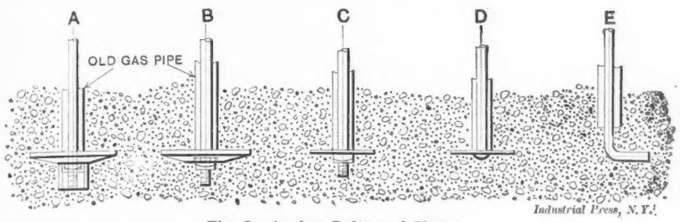

Fig. 3. Anchor Bolts and Plates.

wall is brought up as far as the point *B* and allowed to set a few hours before the forms for the wall proper are started.

When designing foundations the different walls and piers should be made as nearly alike as possible, so that the forms can be made in sections and reset for new piers without alterations.

If possible, foundations should rest on hard pan, gravel, or hard clay. Made ground should be shoveled out for a depth of at least 12 inches below the bottom of the foundation and rammed as hard as possible. The 12 inches should then be filled with clay puddle, well rammed in place. The bearing power of made ground is only about 1 ton per square foot while the best of gravel or hard pan may run as high as 5 tons per square foot. The footings for the foundations should be proportioned with this fact in view, even varying the different parts of the same footing; the idea being to keep the settlement as uniform as possible.

If the bottom course of the foundation rests in water, the concrete must be treated a little differently. If there is only a few inches of water, say less than 12 inches, the concrete may be mixed dry and dumped carefully into the trench and slightly rammed. Should the water be much deeper the concrete may be mixed as for ordinary work, tied up in jute sacks, and the sacks laid closely in the trench, taking care to bond them together after the fashion of brickwork.

Proportion.			Required for one Cubic Yard.		
Cement.	Sand.	Gravel.	Bbl. Cement.	Cu. Yard Sand.	Cu. Yard Gravel.
1	2	4	1.34	0.41	0.81
1	2	5	1.17	0.36	0.89
1	2½	5	1.10	0.42	0.83
1	3	5	1.03	0.47	0.78
1	3	6	0.92	0.42	0 84
1	3½	7	0.80	0.43	0.85
1	4	8	0.71	0.43	0.86

After the foundations are finished to within ½ inch of the top, a layer of rich cement mortar, composed of 1 part cement to 1 part sand, should be put on, and swept off perfectly level with a straightedge. After this mortar has taken its first set it may be smoothed with a trowel. The sides may also be plastered with the same mortar and after it has taken its first set, lined off to resemble stone.

Fig. 3 shows several styles of anchor bolts and plates. *A* is an excellent arrangement, as is *B*. The other styles have little to recommend them except cheapness.

For important work such as engines and rolling mills, the foundations should be arranged with tunnels and pockets so that the bolts may be pushed down through the holes and the nuts and washers put on from below.

When the threads extend into the concrete they should be well oiled to prevent the concrete sticking to them, if it is expected to use the thread for adjustment.

Foundations having piers and tunnels should be provided with ample drains to carry off water and oil; these drains should be large and straight to facilitate cleaning, for they make convenient places for old shoes, bunches of waste, etc.

The cost of concrete depends on the quality of the structure and the location as regards raw material. The foundations of a building with walls of concrete arranged after the fashion of Fig. 2 will cost for labor about $2.00 per yard. This includes carpenter work, handling the material, superintendence, etc. For large and bulky foundations this cost will be less. Portland cement concrete bridge pieces have been put in for $3.00 per yard, complete, including materials and labor.

In estimating the cost of concrete the table in the preceding column, condensed from Thatcher's experiments, may be of value: It will be noticed that the material shrinks about 25 per cent.; this will vary with the amount of ramming the work receives. It might be well to note in the table herewith the fact that from 1—2—4 to 1—3—6 are the limits for first-class work; and from 1—2½—5 to 1—4—8 for second-class work. The weaker mixtures are to be used for filling or where the object is weight rather than great strength.

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AMONG THE SHOPS.

NOTES FROM THE SHOPS OF THE OTT. MERGENTHALER COMPANY.

While in Baltimore, Md., a few weeks ago, several hours were profitably spent in the well-known shop of the Ott. Mergenthaler Co. It is a shop of more than ordinary interest inasmuch as it is the birthplace of the linotype machine, now used in almost all newspaper offices for composition. In fact many of the weekly and monthly publications, including MACHINERY, use linotype composition exclusively for their reading pages. The idea of casting a line or bar of type-metal, commonly called a "slug," from a row of female dies

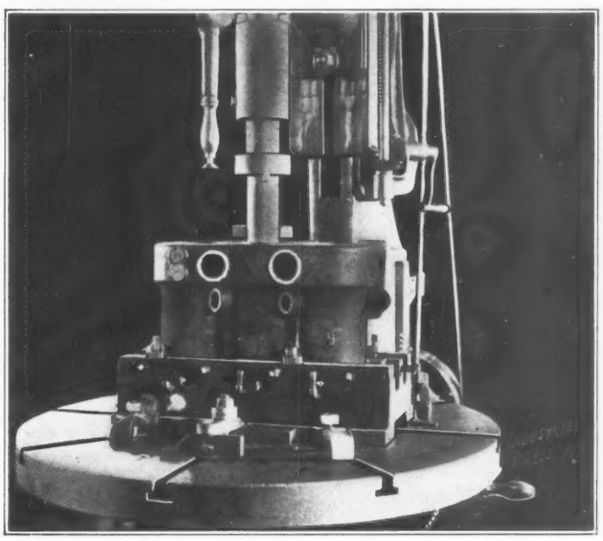

Fig. 1. Boring Three-cylinder Gas Engine on Drill Press.

or matrices with the letters cut intaglio, is distinctly an original conception of Mergenthaler, and is what greatly differentiates his invention from other type-setting and type-casting machines. The name of the machine, "lin-o'-type," was a unique and happy thought, giving in a word an epitome of the principle. The linotype is not now built in this shop, the patents having been sold by Mergenthaler some time before his death to the Mergenthaler Linotype Co., of Brooklyn, N. Y. The shop is still run by the estate, doing high-class jobbing work and making linotype repair parts—an interesting specialty—also manufacturing the "Paradox" or Mergenthaler inserted blade reamer, and an inserted tooth milling cutter.

To say that the reamer *per se* is an important tool in machine shop practice—in fact that it is indispensable wherever standard size holes and interchangeable work is being done—is but to state an obvious fact. It is also obvious that holes cannot be reamed to standard size unless the reamers themselves are kept to a standard. But to keep a set of solid

reamers to a fixed standard is a job that costs a lot of money and time—too much in fact to be done in most shops. With an inserted blade reamer of reliable construction, however, the keeping of a set of reamers to standard size is easily within the possibilities of any ordinary tool-room. With a

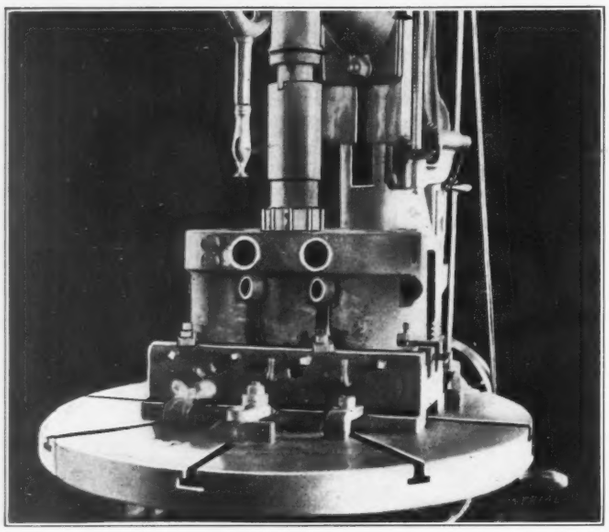

Fig. 2. Reaming Cylinders with Mergenthaler Reamer.

set of adjustable reamers there is the great advantage of being able to use them indiscriminately for all classes of work, and they can be made to do work on the drill-press that ordinarily would be reserved for the lathe or boring mill. The accompanying illustrations, Figs. 1, 2, 3, 4 and 5 illustrate a case in point which is work being done regularly in the Mergenthaler shop.

The casting shown in the half-tones is the cylinders of a three-cylinder gas engine, 4½ inches by 4½ inches, constructed for a leading automobile builder. Fig. 1 shows the cylinders held in a jig and being bored with a boring-bar carrying a two-ended cutter. The boring-bar is supported at the lower end by bushings in the jig, and the cutter removes the scale and most of the stock, leaving .020 inch for reaming to size. Fig. 2 shows a Mergenthaler inserted blade reamer of the shell type mounted on an arbor for finishing the bore. The arbor is made with two keys or feathers, diametrically located, for driving the reamer shell. The blades are preferably made

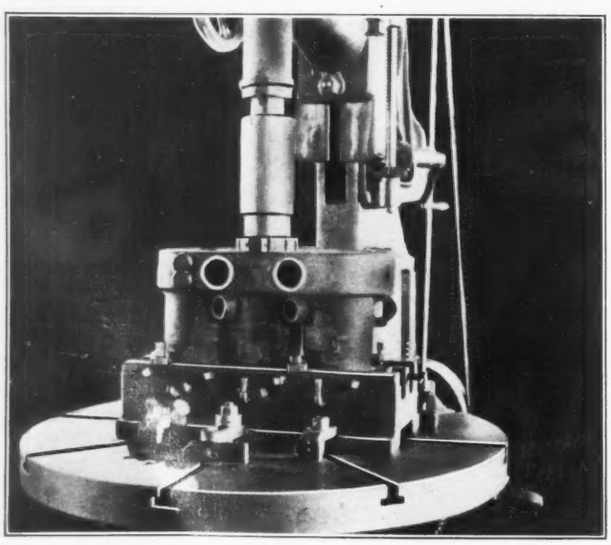

Fig. 3. Tapping Cylinders with Mergenthaler Tap.

short for work of this character in which the drill-press spindle supports and partially guides the tool, the blades being in this case about 1¼ inch long. With the short blades it is easier to make the hole perfectly cylindrical. The importance of boring the cylinders of gas engines as round and parallel as possible, is recognized by all gas engine makers, and some resort to expensive means for securing the desired result. The reamer seems to do the job nicely and in a very simple manner.

In this gas engine the heads are screwed in, seating against a 3-degree bevel next to the counterbore. The threaded part is also tapered as in American pipe thread practice, and an inserted blade reamer is used for this purpose. Following the reaming of the tapered mouths of the cylinders comes the threading operation, which is done with an inserted cutter tap made on the same principle as that of the reamer. The tap for this purpose is shown in position for threading in Fig. 3.

In stating that the tap used is made on the same principle as the reamer, it should be explained that this applies to one style of reamer only. The simplest form of Mergenthaler reamer is made with a steel body having longitudinal slots in which each blade is held by two or more screws tapped alongside and holding the blade by their heads bearing upon a ledge planed on the blade below the cutting edge. Adjustment for wear is made by packing beneath the blades with thin strips of paper. The taps are made on the same principle, forming a solid yet adjustable construction. The universal adjustable Mergenthaler reamer is made so that all the blades may be advanced outwardly simultaneously. Each blade is underlaid with a wedge which can be moved longitudinally by a milled nut, and as all the wedges are made the same

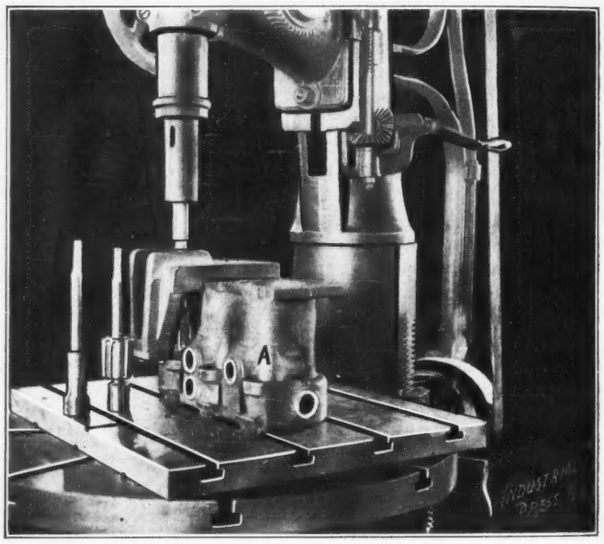

Fig. 4. Counterboring, Reaming and Tapping for Exhaust Bonnets.

taper and all are given the same amount of longitudinal movement, all the blades move outwardly the same distance. In adjusting the simple type of reamer for wear it has been found to answer all practical purposes to compensate for slight wear by packing first under only one blade. A strip of thin cigarette paper under one blade usually suffices. Then as wear increases, the same thickness is packed under an adjacent blade, and so on until all have been packed out. While this practice may not seem exactly correct in theory, it has been found to work well in practice, and is the plan followed. The same applies to the taps.

Fig. 4 shows a cylinder casting on another drill-press table for the operations of reaming, tapping and seating the exhaust valve bonnets. One of the bonnets is shown in the line sketch, Fig. 5. These bonnets screw into the cylinders so that a tight joint is made under the shoulder; also on the surfaces *A A*. The cavity shown in the side of the bonnet matches a passage in the cylinder through which the exhaust gases escape to the muffler. While the pressure is not great it is very necessary that a perfect joint be made at *A A*, nevertheless, as the hot exhaust is very searching and would escape sufficiently under the back pressure of the muffler to be a nuisance, if it were otherwise than tight. A jig is clamped to the cylinder casting, and the reamer shown in place in the cut is first used to ream out the rough cored hole so as to form a guide for a pilot reamer which follows. The pilot reamer is shown stand-

ing off the table next to the casting. This reamer is unique in that the blades are inserted on a spiral. The pilot is made collapsible, that is, the pilot as it reaches the bottom of a cavity, may press its stem upward into the body of the reamer against the resistance of a coiled spring. This familiar expedient is, of course, simply to extend the working range of the pilot over what would be possible with a solid construction

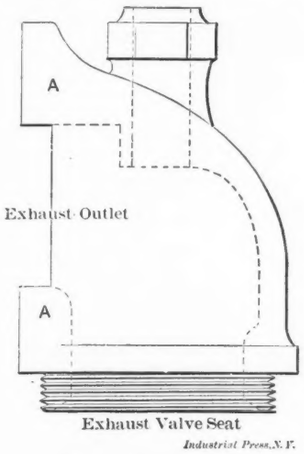

Fig. 5. Exhaust Bonnet.

because of the limited depth of the holes. This reamer performs two functions: It surfaces the side of the casting so as to make a concave bearing for the finished sides of the bonnets already referred to. One of the concave finished surfaces is indicated at *A* in Fig. 4. The reamer also faces the surfaces against which the shoulders of the bonnets are screwed. From the nature of the work that this reamer has to do it will readily be seen why spiral blades are used. They work much smoother than would ordinary straight blades. In fact a reamer under the conditions imposed acts virtually like a milling cutter and performs the same function. Following the reaming operation is the tapping operation which is also done with an inserted cutter tap shown in the cut. It is not necessary to make the holes tapped in the castings for the bonnets bear a certain relation to the face *A*, Fig. 5. This face is brought in correct relation to the cylinder when screwed down tightly against the shoulder, by putting brass gaskets under the shoulders, the proper thickness being obtained by trial.

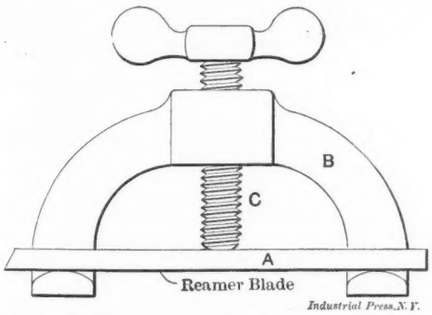

Fig. 7. Clamp for Straightening Spring Reamer Blade.

The crankshafts for the gas engines are steel drop forgings. After the ends have been centered, rough turned and squared up, they are mounted in triangular cast-iron carriers, as shown at *A A'*, in Fig. 6. Two set-screws *D D* are provided in each to lock the shaft firmly. Three hardened steel cup centers are sunk in the face of each piece and, in location, coincide with the axes of the crankpins. The sides of the castings opposite the set-screws, are planed true and at equal distances from the center. In assembling a crankshaft for turning, the carriers are set on a surface plate on their planed edges with the crankshaft in place, but not firmly locked by the set-screws. The crankpins are then located so that their axes will coincide with the lines joining the cup centers, by the use of a surface gage. This is a simple matter. The gage pointer is set so as to just touch the upper side of crank *G'* and by the process of trial and error, the crank G'' is made to stand at the same height from the surface plate as *G'*. This being done, the cup centers *C C C* will be found to coincide with the crank axes. In turning the cranks it is the plan to avoid removing metal in the lathe if it can be done on the milling machine. Therefore the sides of the cranks, as at *F F*, are milled off with straddle mills instead of doing it slowly on the lathe with always the imminent possibility of having the tool catch and spring the crankshaft out of alignment.

The manufacture of reamers is distinctly separate from the making of linotype repair parts and the jobbing work. No pains are spared to make a first-class product in every particular. The general foreman is practically given *carte blanche* to use the best material and means for producing this product. An interesting phase of this work is hardening and tempering the blades. The hardening is done in a "dark room," that is, a room that is shielded from the direct rays of the sun so that the interior is in a perpetual gloom. This provision is, of course, so that the hardener can more easily determine the particular shade of "cherry red" which he has found best suited for reamer blade hardening. "American" gas furnaces are employed for hardening and tempering. In the hardening process it is inevitable that some of the blades will spring out of truth. These are placed in a clamp, Fig. 7, and a certain degree of pressure applied by the thumbscrew before tempering. The clamp with its blade are then dipped into a bath of Houghton's tempering oil which is kept at a temperature of about 450 degrees F. The temperature is indicated by a Queen & Co.'s glass thermometer immersed in the oil and as the oil bath is heated by a gas furnace, the regulation of the temperature to the exact degree required is an easy matter. Of course all the blades are tempered in the oil bath the same as those which are sprung, but these are dipped without being clamped, as are those that are sprung.

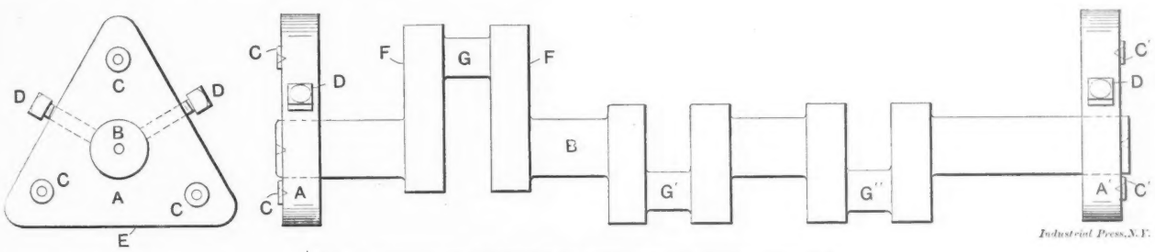

Fig. 6. Carriers and Mounting for Turning Three-throw Crankshaft.

Among other interesting features of this shop which are the product of Mergenthaler's genius, are a number of his universal milling machines. Quite a number of these machines were built and sold. They are unique in a number of features, having for instance, geared feed. So far as we know this is the first knee-and-column type of milling machine built and sold having geared feed.

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In a paper read June 4 by Dr. A. Haarmans of Osnabruck, Germany, before the Mining and Smelting Section of the International Chemical Congress held in Berlin, the statement was made that 19,000 tons of steel rails are annually ground to dust on the railways of Germany, and it was estimated that the total amount annually destroyed by friction on the world's railways, is about 247,000 tons. It was also stated that in Europe steel ties are now as cheap as wooden ones, the cost being of course based on their comparative durabilities.

ELECTRICAL EQUIPMENT OF AN ARCHITECTURAL IRON WORKS.

The shops of the Snead & Company Iron Works, Jersey City, N. J., have recently been completely equipped with Crocker-Wheeler electric motors, the installation including motors for driving both tools and cranes. These shops manufacture ornamental and structural iron and steel, and as the material handled is largely of a bulky nature, requiring considerable floor space, line shafting would have had three marked disadvantages: The necessarily long lines would consume an

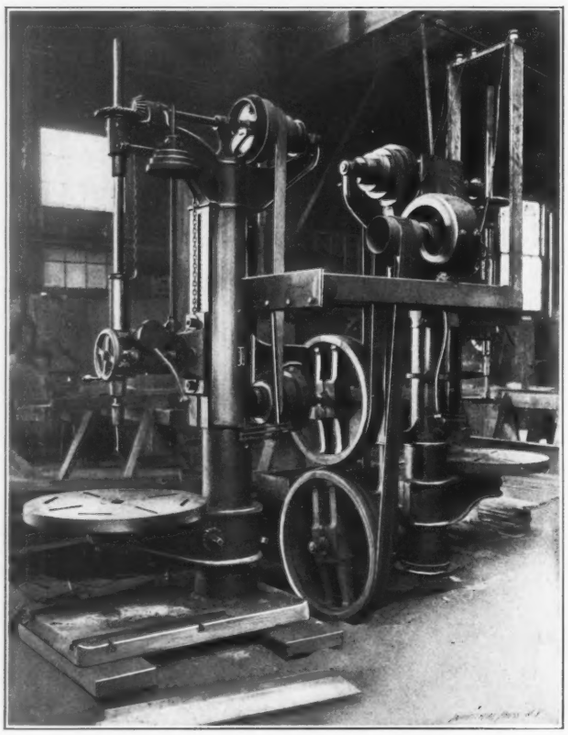


Fig. 1. Peculiar Belt Drive for Drill Presses.

excessive amount of power in friction, would render the convenient placing of the driven members difficult, and with the accompanying belts would interfere with the crane and derrick facilities needed for handling the heavy product.

The buildings, exclusive of the office, afford a total floor space of 31,350 square feet divided among the various departments, including foundry, charging-room, compressed air plant, fitting shop and box-shelf shop. The foundry is in a building 280 feet long by 52 feet wide, and is traversed by two cranes. One, which has been in use for some time, was built by the Yale & Towne Manufacturing Company, and is equipped with three Crocker-Wheeler series motors, with a new Niles crane similarly equipped. The blast for the cupolas is supplied by a Roots rotary blower, No. 6, driven at about 180 revolutions per minute through a geared connection to a 45 horse power shunt-wound C. W. motor. This apparatus is housed in an adjoining smaller building, along with a 12 x 12-inch air compressor, built by the Norwalk Iron Works, used for the supplying of compressed air to the pneumatic chipping and riveting tools, hoist, drills and sand shakers. The compressor is driven by an overhead 45 horse power C. W. compound motor and is capable of delivering 256 cubic feet of free air per minute under a pressure of 80 pounds per square inch. An ingenious disposition has been made of the old 80 horse power boiler, formerly used to furnish steam to a steam-driven air compressor, by now utilizing it as an air storage tank to steady the fluctuating demands upon the compressor.

The fitting shop contains a variety of tools, of which the following data concerning motor equipment may be of interest, especially with reference to sizes of motors used.

The punches and shears, which may be used interchangeably, for one purpose or the other, by substituting the proper tools, are of Long & Allstatter make and are driven through two trains of gears by Crocker-Wheeler motors. The largest, shown in Fig. 2 accompanying is a No. 00, capable of shearing a 6 x 6 x 1½-inch angle-iron, and is driven at 24 strokes per minute by a 7½ horse power motor running at 1,000 revolutions per minute. A No. 4 punch is driven by a 3 horse power motor reducing in speed from 1,050 revolutions to 32 strokes per minute. A No. 0 and a No. 1 shear are each driven at 24 strokes per minute by a 5 horse power motor running at 1,065 revolutions. A special lathe for facing off the ends of columns is belt-driven with two speed reductions by a 15 horse power compound motor running at 840 revolutions per minute.

Two drill-presses, illustrated herewith, being of about the same size and usually running simultaneously, are placed back to back and driven from a single belt passing successively over the driving pulleys of each press and the motor. The motor is supported between and above the presses on brackets attached to the press frames. A third smaller drill-press is driven by a 1 horse power motor, and the fourth, with a small emery wheel and a grindstone is driven through a short line shaft by a 3½ horse power motor. A Norton double emery grinder with two 18-inch wheels is driven by a 3 horse power motor at 1,100 revolutions per minute and a Diamond Machine Company's face-grinder with a 14-inch wheel and a 36-inch stroke of bed, operates from a 5 horse power motor.

The remainder of the fitting shop embraces a cold-saw belt-driven by a 5 horse power shunt motor running at 1,065 revolutions; a New Haven planer with a 10-foot by 30-inch bed, driven by a 6½ horse power compound motor; a Gould & Eberhardt 24-inch shaper belted to a 2 horse power compound motor, and a No. 5 Sturtevant blower for all blacksmith work, delivering 4,500 cubic feet of air per minute when driven at 1,090 revolutions per minute by a 4 horse power motor.

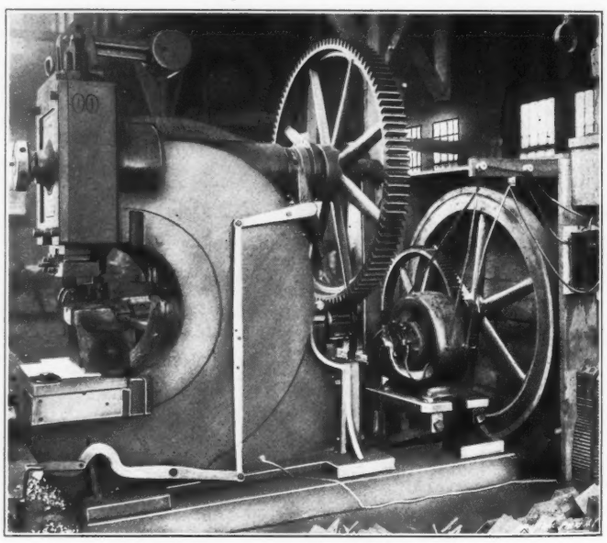


Fig. 2. Motor Attachment for Punch and Shear.

In the pattern shop individual drives are also employed. The buzz-saw is driven by a 5 horse power motor. A semi-inclosed type of motor is used for this on account of its heating less at high speed, and as it was necessary to prevent the saw-dust carried back by the belt from eventually finding its way into the working parts of the motor, a fan was placed on the end of the motor shaft with the blades bent so as to blow the dust away from the motor.

* * *

The high price paid by the United States Government for armor plate, affords a large profit to the manufacturers, no doubt, but then it is not all cream. The material used for making armor plate is not a simple carbon steel, casehardened as some would have us believe, but is a steel that is alloyed with nickel and sometimes chromium, both of which are high-priced metals. Nickel has the effect of toughening the steel, and chromium hardens it. The heat treatment is also a complicated process that has to be carefully conducted to secure uniform product, having a hard face and a tough back.

METALLIC PACKINGS.*

THEIR HISTORY AND DIFFERENT FORMS.

The author, Mr. Charles Longstreth, introduces his subject by saying that metallic packings attracted attention at a very early date in the history of the steam engine. Edmund Cartwright's patent of 1797, No. 2,202, specifies the following: "The piston rod is also packed upon the same principle, that is to say, solely with metal which is thus done: The top of the cylinder being made true and smooth, a flat ring, cut into segments, lies upon it and embraces the piston rod, toward which it is pressed inward by springs; this ring is inclosed by another, divided into segments, and to which it is pressed inward by springs. The segments of the inner and outer ring must be so placed as to break joint. The rings are covered by a third, which is held down by any adequate pressure, as in the piston; the whole may be encircled by a box for holding oil, etc." This covers the principal points of quite a number of the well-known packings of the segmental block type in use at the present time.

Also Richard Trevithick's patent of 1815, No. 3,922, particularly alluded to a combination of fibrous and metallic packings. He also describes a design that is practically the basic principle of the present double packings, that is, two stuffing boxes with intervening space. At that early date he was impressed with the friction caused by the fibrous packings, and used his double packing with the idea that he could overcome some of this friction by allowing steam or water to occupy the space between the two packings.

John Barton's patent of 1816, No. 4,062, and drawings which accompany it, plainly show a very ingenious segmental block packing, which would probably be considered a good one even at the present day.

The purposes of a piston-rod or valve-stem packing are to prevent leakages of steam both along the rod or stem, and also between and around the packing, and to do this with minimum pressure and friction. At the same time the packing should not be designed to act as a guide for the rod or stem, thus partly usurping the function of the crosshead guide. The packing, on the contrary, should be designed so that it will be sufficiently flexible to follow slight lateral movement of the rod while remaining steam tight. It is to the realization of this latter requisite that the more recent designs of metallic packings owe their superiority over the old-fashioned fibrous or the early designs of metallic packing.

The character of the rods to be packed must be considered in the design of metallic packing. If the moving parts require no guiding, as in the ordinary type of steam pumps, the problem is a comparatively simple one. If the moving part has a slight vibratory as well as a reciprocating motion, then the problem becomes quite difficult to solve. The vibratory motion, being caused by the slight difference in diameter between the piston and cylinder, as well as by the play between crosshead and guide, changes at every point of the stroke and varies with every position of the connecting rod. Slight vibratory motion may also be caused by the roll or pitch of the vessel, in the case of marine engines, and while the amount of such motion may seem trivial to some, it bears a very important relation to the wear of both packings and rods.

In order properly to classify packings to meet the varying conditions to which they are subjected we should divide them into two general classes:

1. Rigid packings of the male and female-ring order.

2. Flexible packings, which can again be subdivided into two types—the segmental or block design and the conical-ring form.

The design of rigid packings is shown in Fig. 1. It prevents the leakage of steam around the stuffing box, by having the outside of the female rings pressed against the stuffing-box wall. In order to prevent the leakage of steam along the rod, the inside of the male rings is pressed toward the rod. The force holding these rings against the various surfaces is exerted by pressing the gland against the end of the rings. As ordinarily designed, the great trouble with such packings is to secure a steamtight joint against the wall of the stuffing box, as there is no wear there. This can only be accomplished by producing great friction and pressure against the rod, and as the packing fills the entire space between the walls of the stuffing box and the rod, it does not allow any of the vibratory motion previously alluded to.

Where vibratory motion exists and this class of packing is used, the packing is compelled to do a large amount of the guiding that should be taken up by the walls of the cylinder and the guides. The absurdity of attempting to do this part of the work with a surface so small and a material so soft as that of the packing will be at once apparent to the engineer.

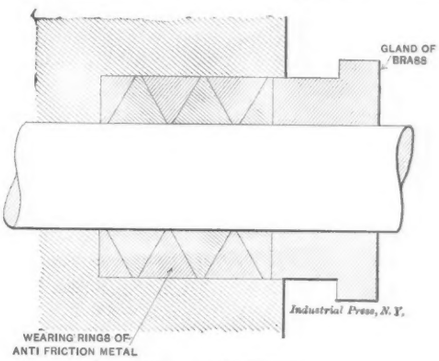


Fig. 1 Rigid Packing.

It can readily be seen why piston rods fitted with this type of packing require such an excessive amount of lubrication to prevent the rods from running hot. Frequently, with packings of this type, rods become so hot as to melt the anti-friction metal and cause it to run from the stuffing box. This packing, therefore, can only be used with success on valve stems and rods of auxiliaries, as well as on the appurtenances to boilers and engines, and wherever the motion of the rod or stem is comparatively small and infrequent. Packings of this design are of very early origin, the first of them being used about 1843.

The flexible types of packings, which may be considered as designed on engineering principles, differ entirely from the foregoing. The new designs do not attempt to fill the entire stuffing box, as steam is allowed to enter the stuffing box and the packings thus have a chance freely to acquire a vibratory motion. The steam leakage around the walls of the stuffing box is duly taken care of by metal or other gaskets under glands, and by sliding faces ground steamtight. The gland is thus pulled up tightly against the intervening joint and the cylinder head, and all the adjustment takes place from the inside.

The segmental ring or block form of flexible packing is shown in Fig. 2. These packings are usually metallic segments, although it is often the case that they are simply blocks of metal held fairly close to the rod by some form of

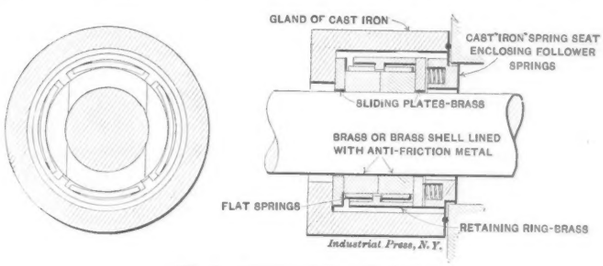

GLAND OF CAST IRON
CAST IRON SPRING SEAT ENCLOSING FOLLOWER SPRINGS
SLIDING PLATES-BRASS
BRASS OR BRASS SHELL LINED WITH ANTI-FRICTION METAL
FLAT SPRINGS
RETAINING RING-BRASS
Industrial Press, N.Y.

Fig. 2. Segmental Ring Packing.

pressure—that is, either by means of a spring, by the pressure exerted by the steam, or by a combination of both these forces.

There are probably more different designs of this class of packing than of any other, since such forms may be designed by people of comparatively little experience, and give fairly good satisfaction where moderate steam pressures are used.

Those in charge of marine machinery should be impressed with the fact that the quality of the steam supplied to the engines will have a very important influence upon the life of the packing. There is no doubt but that even a slight

* Abstract of an article in the Journal of the American Society of Naval Engineers for May, 1903.

amount of water in suspension in the steam brings with it from the boiler some gritty substance. While this amount may be apparently of an inconsiderable nature, it is sufficient to greatly increase the wear of metallic packings. The relative life of metallic packing when using both dry and wet steam was evidenced in the case of sister ships belonging to the same line, running on the same service and carrying the same pressures. On the high-pressure rod of one ship, where no care was taken to secure dry steam, the life of the packing averaged thirty days' wear. On the engines of the sister ship, where care was taken to secure dry steam, the same packing has been in use for several years.

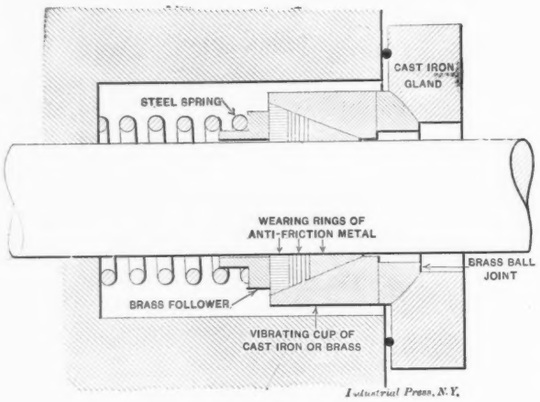


Fig. 3. Conical Ring Packing.

The principal objection to segmental packings is that they are expensive to manufacture and necessitate care in maintenance. They are generally of a complicated nature, since they comprise a large number of springs, segments and rings. As the packing is forced to the rod by the steam pressure, the friction on the rod or stem increases proportionally with increase in boiler pressures. In other words, it is almost impossible to use packings of this character on a triple-expansion engine and obtain anywhere near the same length of wear from the packings for the three different cylinders; the high wearing out most rapidly, the intermediate wearing out next rapidly, and the low lasting the longest.

The last type of packing to be considered is usually known as the conical ring, and is shown in Fig. 3. This type of packing has given better satisfaction under adverse conditions than all others, and is the packing used on 90 per cent of the locomotives running in the United States. This in itself is an evidence of its ability to run under adverse conditions with little repair.

The principle of this packing is that conical, soft-metal rings are pressed against the rod, and thus packing is accomplished by the rings being forced into a solid cup bored to conform to the outside of the rings. These rings are pressed into the cup partly by a spring, but principally by the steam itself. If the pressure of steam was constantly on the packing the springs would be unnecessary, as they are used merely to hold the packing in place while steam is shut off the engine.

In order that this packing shall be satisfactory, the cup must not be allowed to touch the wall of the stuffing box at any time. The proper design as well as the character of material of these packings is therefore the most difficult problem to be solved in the packing business, as the mixture of metal in the rings, as well as the form of the outside of the rings, must be such that the packings will merely prevent the leakage of steam and not cause excessive friction.

Where properly designed, these packings can be made to give approximately the same length of wear on all the rods of a multiple-expansion engine. However, in practice it has been found that this is not entirely desirable, and so, when usually designed by first-class manufacturers, the high-pressure packings wear out a little while before the intermediates and low.

It will often be noticed that the shape of rings in packings of this character on the high-pressure rods is slightly different from that on the intermediate and low. In order to permit cheap and rapid repairs, it is desirable to have a uniform quality of metal used for the rings, while it is also necessary to have the form of rings balance differences in pressure.

With this type of packing there is absolutely nothing that comes in contact with the rod except the white-metal rings. The glands, neck bushings, cups, followers, etc., are bored considerably larger than the diameter of the rod or stem, and as the rings are made of soft metal and properly designed, they will cause very little friction and wear on rods.

Many experiments and tests have lately been made with packings of this nature, and where proper provisions are made to allow the rings and their inclosing cups to move freely with the rod, they have been universally satisfactory. In order to allow the cup completely to accommodate itself to this condition, it is advisable to provide a ball joint in addition to the sliding face previously alluded to. A hot rod from packings of this type is practically unknown, and in railway service, where at the present time all details of this kind are apt to be carelessly handled, that they operate with any degree of success at all speaks volumes for their design. In addition to the above, the advantages of this type are that wearing parts are inexpensive and easy to replace.

The disadvantage of these packings, if it can be called a disadvantage, is that they will not work properly on a rod unless the rod is cylindrical. When packings are applied, if the rod is cylindrical, even though it is grooved, these packings in a short time will become steamtight. There are many cases on record of extremely long service without renewals of this class of packing. Cases are on record of ten years' run, although the average life may be taken as from two to five years, and then the packings may be put in as good condition as they were when new, by merely supplying a few inexpensive soft-metal rings.

It is remarkable how little attention has been paid to this engineering subject and the ignorance of proper principles upon the part of engineers. It really requires very little cross-section of rings to do this work of packing, provided everything is properly designed; and the old notion, that the more rings and the deeper the stuffing box the better the packing, should be discarded as entirely wrong. If the packing manufacturer were consulted at the time engines were designed, it would often be possible on the ordinary marine engine to lower the cylinders from six to eight inches, and keep the other proportions of the engine exactly the same. From this

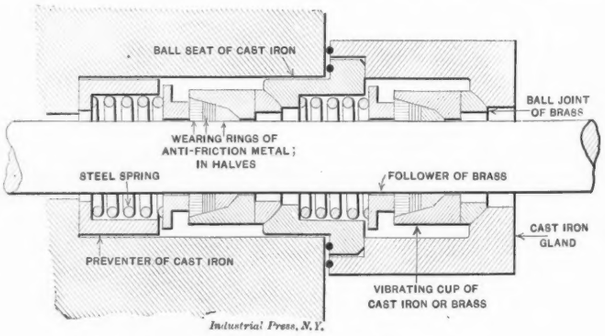

BALL SEAT OF CAST IRON
BALL JOINT OF BRASS
WEARING RINGS OF ANTI-FRICTION METAL; IN HALVES
STEEL SPRING
FOLLOWER OF BRASS
CAST IRON GLAND
PREVENTER OF CAST IRON
VIBRATING CUP OF CAST IRON OR BRASS
Industrial Press, N.Y.

Fig. 4. Double Packing for Marine Work.

can be readily seen the importance of this subject. Think of the weight of metal saved in six inches of housings, piston rods, valve stems, etc.

In practice, for most stationary and marine engine work, double packing is used, as shown Fig. 4, that is, practically two stuffing boxes, the packing nearest the cylinder doing all, or nearly all, of the real work. The lower packing does little or no work until the upper packing is worn out or fails or leaks, when the lower packing catches this leakage or takes up the work in case of failure.

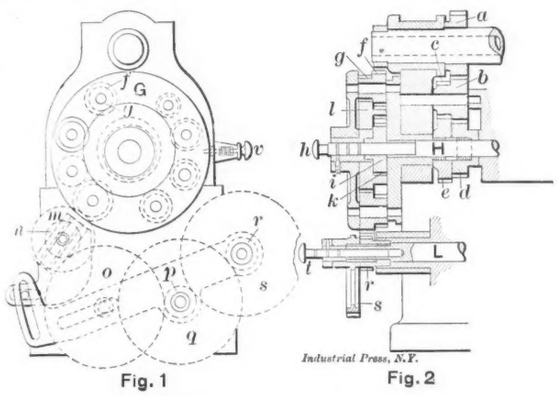
* * *

Does steel improve by age, or, in other words, will a bar of steel that has stood in the warehouse a long time make a better tool than one fresh from the hammers or rolls? Some persons think it does improve, and there are those who buy their steel ahead of requirements so as to season it as lumber is seasoned.—*Sparks from the Anvil.*

THE EVOLUTION OF THE CHANGE GEAR.—3.

OSCAR E. PERRIGO.

Again in Patent No. 684,433, also dated October 15, 1901, Herman R. Isler tries his hand at the change gear problem, this time adapting the plan of a disk of gears. These two applications for patents followed each other at intervals of about two and a half months. This device is much more simple than his former effort and is arranged on the popular eccentric plan first shown by Burdick in 1895. The pinions of the disk of gears are operated by sliding keys. In the drawing Fig. 1 is an end elevation of the device, and Fig. 2, is a vertical, longitudinal section. Power is transmitted from the head spindle by the gears *a*, *b*, *c*, *d*, and *e*, the latter four being arranged in two pairs, *d*, and *e*, being brought into action by means of a sliding key, operated by the knob *h*, thus giving the shaft *H*, two changes of speed. Gear, *i*, is



Industrial Press, N.Y.

Fig. 1 Fig. 2

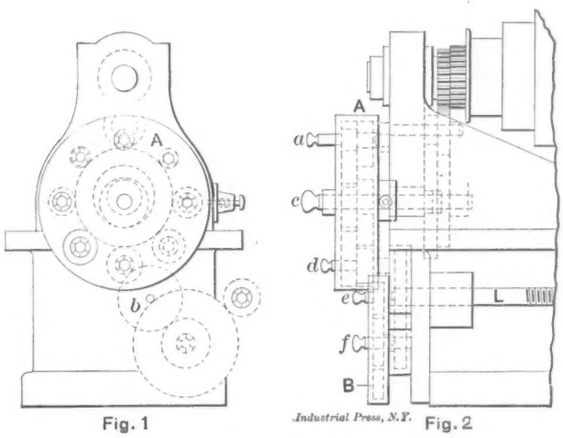
Herman R. Isler. No. 684,433, Oct. 15, 1901.

splined on the shaft *H*, and engages the internal gear *k*. Formed on the outside of the internal gear *k*, is the gear *l*, which is adapted to engage a series of gears *f*, *g*, etc., of varying sizes disposed around it as shown in Fig. 1. These gears are in pairs, one of which is adapted to engage the external gear *l*, and the other to engage the idle gear *m*, to which is attached the gear *n*, engaging the gear *o*. Upon the next stud are the gears *p*, *q*, engaging similar gears *r*, *s*, on the lead screw *L*, the latter being brought into individual action by the sliding key controlled by the knob *t*. The revolving disk *G*, carrying the series of gears *f*, *g*, etc., is held in place in any desired position by the spring pin *v*.

Once more Herman R. Isler attempts to solve the change gear idea, in Patent No. 704,645, dated July 15, 1902. He adheres to the "disk of gears" form and improves on his previous device, retaining the eccentric method of mounting and adding a supplementary arrangement for multiplying the speeds obtained by the pinions in the disk. The former are still controlled by sliding keys. In the drawing, Fig. 1 is an end elevation, and Fig. 2 a front elevation of the device, the series of gears of the disks being represented by dotted circles. Power is conveyed from the head spindle in the same manner as in his last patent, and the gears of the first disk *A*, are arranged in the same manner. But instead of the final gear driving direct to the lead screw, it conveys motion by means of idle gear, *b*, to a second disk of gears *B*, arranged substantially in the same manner and designed to still further multiply the possible changes of speed at which the lead screw *L*, may be driven. The knobs, *a*, *c*, *d*, *e*, *f*, are adopted to effect the various changes by throwing into and out of engagement a series of clutches connecting the required gears and disconnecting those not needed. One disk or case full of revolving gears, most of which would probably be ruined by the breaking of a single tooth in any one of the numerous gears, is bad enough, but when another box of "gear trouble" is added it would look like hunting for difficulties that are apt to come fast enough at best.

Richard K. LeBlond, of Cincinnati, Ohio, shows us in his Patent No. 706,186, dated August 5, 1902, a practical and very mechanical method of obtaining a large variety of feeds and threads pitches by the combination of three cones of small gears, and the necessary sliding gears for connecting either the lead screw or the feed rod, the whole being operated by two handles and a knob. The arrangement of shafts, gears, and yokes is very compact and is principally within the lathe bed. One peculiarity of this arrangement is that the yokes or "travelers" carry not only connecting gears but cones of gears. This is also seen in the device of Peter and William Shellenback in 1892. In the drawing, Fig. 1 is an end elevation of the device, and Fig. 2 is a development, in section, of the train of gears from the regular connecting gears from the head spindle to the lead screw and feed rod. The path of the transmission of power, is from the head spindle gear, *a*, to *b*, and *c*, upon the shaft *d'*, on which slides the traveler *D*, carrying the pinion *d*, and in whose forked end are journaled the gears *e*, *f*, *g*, on the shaft *g'*, adapted to engage as desired the gears *h*, *i*, *k*, on the shaft *h'*. The gear *i*, engages the gear *l*, of the cone of gears *l*, l^1, l^2, l^3, etc., mounted on the shaft *x*, journaled on the sliding lever *M*, which also carries the connecting pinion *m*. By proper manipulation of the lever *M*, the gear *l*, may be made to engage either of the gears *h*, *i*, *k*, and also any gear of the cone of gears *l*, l^1, l^2, l^3, etc., may engage the gear *k*, thus producing a large number of changes. Upon the shaft *y*, is fixed the gear *n*, which may by means of the knob *z* be brought into engagement with the gear *p*, on the lead screw *L*, or the gear *o*, on the feed rod *R*. The levers *D*, and *M*, are operated and held in any desired position in the usual manner, as shown in Fig. 1.

It is evident that when William T. S. Johnson, of Cincinnati, Ohio, set out to devise the arrangement for which he obtained Patent No. 706,665, dated August 12, 1902, he was determined to produce something that would at least be novel, whatever other claim it might have to interest mechanical men. In this case the oft-recurring cone of gears is placed upon a sleeve journaled directly upon the head spindle of the lathe in place of the usual head cone for driving the lathe, and providing only one large pulley for that purpose. The well-known system of a traveling pinion is used on a supplementary shaft, upon the end of which are placed two gears which, in connection with two others on a stud, form the usual combination for multiplying the changes by two. In the drawings, Fig. 1 is an end elevation, and Fig. 2 is a front elevation and partial vertical section. The usual back gears are of modified construction as seen in Fig. 2, the face



Industrial Press, N.Y.

Fig. 1 Fig. 2

Herman R. Isler. No. 704,645, July 15, 1902.

gear *b*, being fixed to the head spindle and the disk *a*, used as a means of connection between it and the single driving pulley *c*, the connection being by spring pins, as shown. The cone of gears, *d*, d^1, d^2, d^3, etc., is mounted and fixed upon a sleeve *e*. Sliding upon the supplementary shaft *f*, is the lever *g*, carrying the connecting pinion *h*, through which power is transmitted to the gears *i*, *k*, and thence to similar intermeshing gears *l*, *m*, to the gear *n*, on the lead screw *L*. Either gear *i* or *k* may be connected to the shaft *f*, as desired, by means of a sliding key operated by the knob *p*. Thus, while the number of speeds of the head spindle is very much reduced, (unless some form of variable speed countershaft, or an easily controlled electric motor is used),

the number of speeds of the lead screw is very easily obtained. Yet the sacrifice of the usual five-step driving cone would not seem to commend itself to practical mechanics.

Having now described in detail the various patents up to a quite recent date, comparing them with each other, and having traced as clearly as may be the evolution of the change gear, it seems proper to offer some observations in the form of a summary of what has been presented.

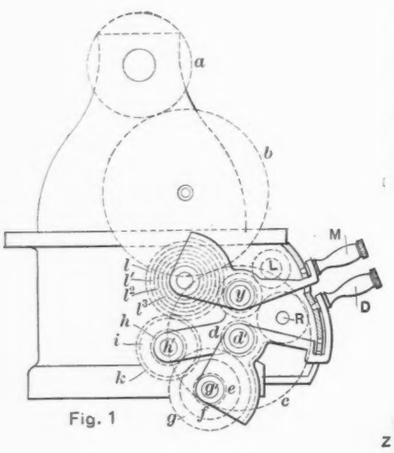
The predominating features of all these various methods of producing a variable feed or a number of pitches of thread cutting, is the use of the "cone of gears," or a collection of gears arranged on a shaft "in step-like form." The second feature is that of providing, in connection with the cone of gears, two or more pairs of gears, which may be termed multiplying gears, each two pairs multiplying by two the number of changes produced by the cone of gears, or dividing in the same ratio the speeds already attained. By multiplying gears is meant, pairs of small gears, usually a larger and a smaller on each of two shafts, say of 24 and 48 teeth, which may multiply or divide the speed by two. These may be used with gears of equal size, for instance with the above numbers of 24 and 48 teeth the equal gears may each have 36 teeth. When used in connection with the cone of gears, they multiply the changes given thereby, as for instance, if the cone is of seven gears, the number of changes is readily made fourteen, twenty-one or twenty-eight.

A radical departure from these methods was made, first by Edward Flather, April 2, 1895, and Benj. F. Burdick, April 23, 1895, and later by Wm. L. Shellenback, December 5, 1899, and in another patent, February 5, 1901, and by Herman R. Isler, October 15, 1901, and July 15, 1902. This consisted of arranging the series of various sized change gears on a circular disk, and usually around a central gear from which any one of them was operated, or by which the motion was communicated to the lead screw. In the later patents they are arranged in an eccentric form so that only the pair needed at the time will be in action. It is doubtful, however, if either of these devices will come into general use, owing to the large number of parts, the complication and expense which they involve, as well as the difficulty of operating them by the average grade of machinists who might be called upon to use them, and the danger of breaking the gear teeth.

The one inventor who departed from all the usual forms on which others had seemingly rung all possible changes was Carl J. Paulson, June 18, 1895, who adopted a series of toothed rings, one within the other, which are engaged by a swinging pinion when any desired ring is moved out to its active position.

It is a somewhat remarkable fact that with the exception of the first claim of Bancroft and Sellers, 1854, all the claims in the twenty-seven patents herein discussed, are what is known as "combination claims," and that in all the two hundred and thirteen claims in this series of patents the devices and arrangements are often so near a counterpart of some prior patent that the delicate points of decision upon them in the Patent Office must have been a hair-splitting process, governed more by the exact and carefully worded phraseology of the claims than the difference in the ideas of the inventors from those of former patents. Bancroft's claim, referred to above, is this: "The method of varying the motions of the mandrel (head spindle), and screw shaft, or leader, by means of two series of wheels, each series consisting of wheels of different diameters, and all the wheels of one series being connected and turning together, and imparting motion to all the wheels of the other series with different degrees of velocity, substantially as described." Inventors have been harping on that same string ever since. It may be truly said that Edward Bancroft and William Sellers are the originators of the method of producing variable feeds for turning or thread cutting in a lathe by the use of the "cone of gears." In these articles there have been twenty-seven patents considered, comprising all relating to this subject on file in the United States Patent Office up to August 12, 1902. The following is the entire list.

Edw. Bancroft-Wm. Sellers	No. 10,491	February 7, 1854.
John Humphreys	No. 83,774	November 3, 1868.
Frederick B. Miles	No. 111,859	February 14, 1871.
William Bley	No. 156,758	November 10, 1874.
Charles W. Riley	No. 233,702	October 26, 1880.
Andrew Hyde	No. 247,764	October 4, 1881.
George A. Gray, Jr.	No. 252,760	January 24, 1882.
Joseph Flather	No. 462,481	November 3, 1891.
Peter & William Shellenback	No. 468,183	February 2, 1892.
Wendel P. Norton	No. 470,591	March 8, 1892.
William Shellenback	No. 518,164	April 10, 1894.
Wendel P. Norton	No. 519,924	May 15, 1894.
Salmon W. Putnam	No. 525,863	September 11, 1894.
Edward Flather	No. 536,615	April 2, 1895.
Benjamin F. Burdick	No. 537,816	April 23, 1895.
Carl J. Paulson	No. 541,385	June 18, 1895.
Herbert L. Flather	No. 592,966	November 2, 1897.
Ernest J. Flather	No. 595,562	December 14, 1897.
Benjamin A. Wheeler	No. 602,924	April 26, 1898.
William L. Shellenback	No. 638,359	December 5, 1899.
William L. Shellenback	No. 667,406	February 5, 1901.
Edward A. Muller	No. 679,568	July 30, 1901.
Herman R. Isler	No. 684,432	October 15, 1901.
Herman R. Isler	No. 684,433	October 15, 1901
Herman R. Isler	No. 704,645	July 15, 1902.
Richard K. LeBlond	No. 706,186	August 5, 1902.
William T. S. Johnson	No. 706,665	August 12, 1902.



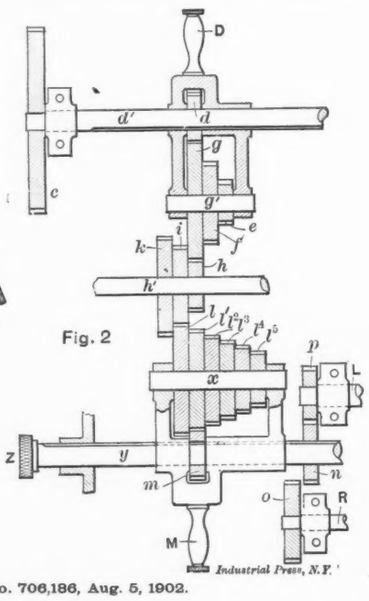


Fig. 2

Richard K. Le Blond. No. 706,186, Aug. 5, 1902.

Of the twenty-seven inventions, fifteen, viz.: Bancroft and Sellers, Humphreys, Miles, Riley, Hyde, J. Flather, P. and W. Shellenback, Norton, W. Shellenback, H. L. Flather, E. J. Flather, Wheeler, Isler, LeBlond, and Johnson, make use of the "cone of gears" in various positions and methods of operation.

Of the fifteen inventors who use the cone of gears there are nine, viz.: Humphreys, Miles, Hyde, Norton, H. L. Flather, E. J. Flather, Wheeler, LeBlond, and Johnson, who use the "traveler" and its connecting pinion to operate the intermediate shaft at its variable speeds.

As to the location of the cone of gears, Humphreys and Johnson put it in the head; Bancroft and Sellers, Miles, Riley, and Hyde, place it at the end of the head. P. and W. Shellenback, H. L. Flather, E. J. Flather, Isler, and LeBlond locate it in the bed; E. J. Flather forming a space in the front of the bed for that purpose. Norton puts the cone of gears in front of the bed, Wheeler puts two cones of gears at the end of the bed and one in the apron. Isler puts two cones of gears in the bed and four at the back of the bed.

Of the methods of operating the cones of gears, ten of the inventors fix the cone of gears on the shaft. Bancroft and Sellers have one cone loose on the shaft and connected by a removable pin, while the other cone is fast to the shaft. Riley, J. Flather, Wheeler, and Isler, use sliding keys. Johnson fixes his cones of gears on a sleeve, loose on the head spindle, while P. and W. Shellenback have their cone of gears slide on the shaft in order to bring the gears successively

into engagement with the connecting pinion. Isler uses no less than six cones of gears, while Wheeler uses three.

In the twenty-seven patents there are two hundred and thirteen claims, Wheeler leading the number with thirty claims. P. and W. Shellenback have twenty-one. W. L. Shellenback has seventeen. Putnam and W. L. Shellenback (1901) each have fifteen claims. Miles is the most modest in his pretensions, making only one claim, while adding quite as much to the then "state of the art" as some of his later competitors. Wheeler easily "takes the cake" in his specification and claims, its seven printed pages rivalling a Ralph Waldo Emerson lecture.

Fig. 1

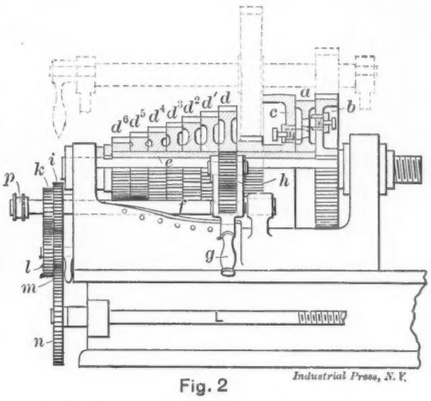


Fig. 2

William T. S. Johnson. No. 706,665, Aug. 12, 1902.

The examination of all the mass of Patents, amounting to one hundred and fifty-six, the selection of those particularly relating to the change gear devices, and the efforts to reduce them to their mechanical requisites have been a long and tedious work. That it is not perfect no one knows better than the author. That it may be of some assistance to conscientious investigators of the important mechanical devices of which it treats is the earnest wish of the writer of these articles.

* * *

The Pedrick & Ayer Co., who for many years have been located in Philadelphia, have now completed new works at Plainfield, N. J., to which point the business has been removed. The plant consists of a main shop 100 by 400 feet, boiler house, engine house, blacksmith shop and pattern storage building.

The main building contains the offices of the company, drafting room, tool room, and storage of principal raw materials and finished parts. The principal portion, however, is taken up by the machine shop proper, the fitting, assembling testing and shipping departments.

The main bay is provided with a 15-ton Shaw electric crane and there are numerous hoists and jib cranes actuated by compressed air. The machine tools are all driven by electric motors, the prevailing plan being to group several machine tools on one motor-driven countershaft. In the testing department arrangements are made to provide practical working conditions for the air compressors, riveters, hoists and cranes, which they manufacture.

The boiler and engine house, with fire wall and metal door between, might be considered as one building. The engine room contains a belted automatic air compressor of the type largely sold by the company and two direct-connected dynamo-engine sets for supplying power and light to the entire works. The sets are 150 kilowatts capacity each, the engines furnished by the Ames Iron Works and dynamos and switchboards by the General Electric Company.

* * *

In a recent consular report the United States commercial agent at Eibenstock, Germany, mentions a large electric crane that has recently been erected in the harbor of Kiel for loading and unloading vessels. It is of the weighted cantilever type, mounted on a structural steel column which gives head room of fully 75 feet under the arm. The capacity is fifty tons.

THE NEW FOUNDRY OF THE BROWN & SHARPE MFG. CO.—2.

In the general description of the Brown and Sharpe Mfg. Co.'s foundry in the last number, brief reference was made to the hot-blast heating system installed by the B. F. Sturtevant Company. There are two heating units, one for the heavy foundry and one for the light foundry, casting cleaning and storage departments, offices, etc. The apparatus for the heavy foundry is in accordance with the most recent ideas on the heating of large buildings and is of sufficient interest to call for special mention. It used to be considered necessary in warming large areas to deliver highly heated air at many different points in order to bring the whole to a uniform temperature. Long sheet-metal distributing pipes suspended near the ceiling, with openings at frequent intervals, were invariably used for this purpose and of course are necessary where there are numerous departments to be heated or the single room or building is of unusual dimensions. If the conditions are right, however, air can be thoroughly distributed without this expedient, and in the case of the heavy foundry of this plant, a building 95 by 160 feet, there are no pipes used. The heated air is delivered at a central point on one side of the building, through a duct having mouthpieces aiming toward different parts of the foundry to diffuse the air as much as possible. The air is delivered in large volume, moderately heated, and consequently is not likely to produce drafts disagreeable or dangerous to the workmen. The heated air comes in contact with the walls and roof where it is cooled somewhat, which causes the current to move toward the floor, warming the lower part of the space.

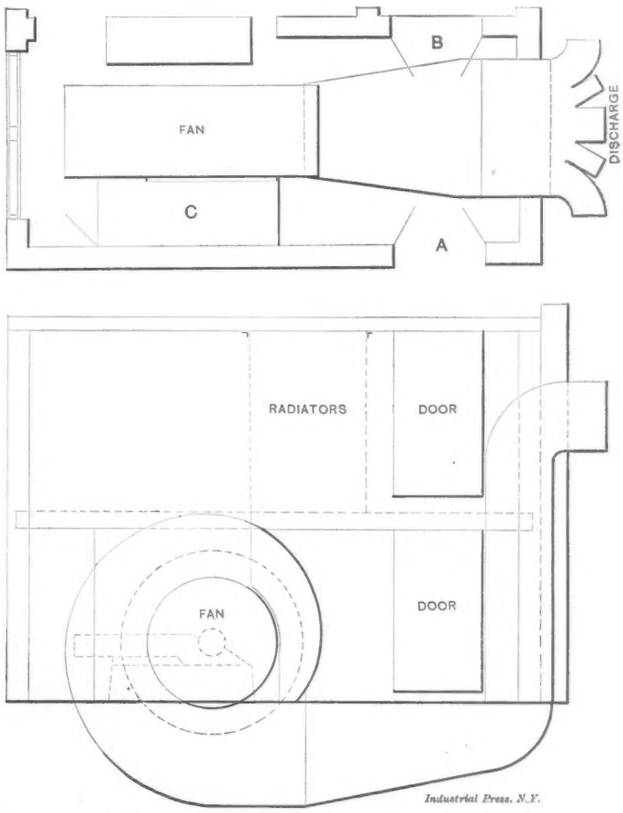


Fig. 1. Diagram of Heating Unit for Heavy Foundry.

In Fig. 1 is an outline plan and elevation showing the fan and duct leading to the foundry. The duct enters at a central point on one side at about 12 feet from the floor and has five short discharge pipes pointing in different directions, as represented in the plan view in Fig. 1. The fan is located in a bricked enclosure with an intermediate floor, on which

the radiator coils are placed. Below, on the first floor, is the fan with discharge duct underneath which leads to the vertical pipe and thence to the openings into the foundry. There are doors, *A* and *B*, in the sides of the enclosure, the two lower doors giving access to the fan and the two upper ones air admission to the radiators. One of the upper doors opens to the interior of the foundry buildings and the other to a light

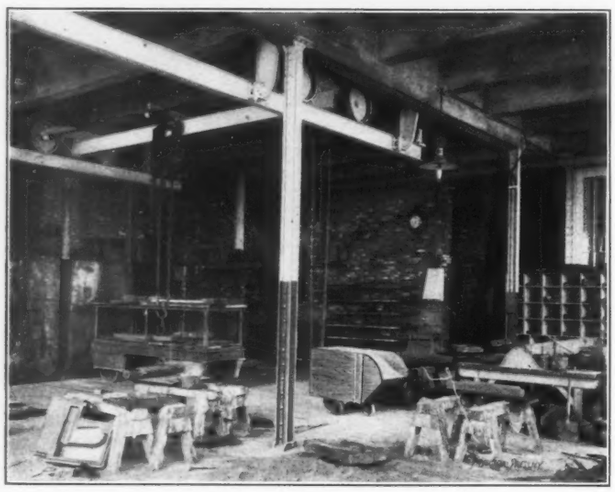


Fig. 2. View in Core Room.

well. The fan draws its supply of air through the duct *C*, from the compartment containing the radiators.

The westerly end of what is known as the "cupola building" is fitted up as the core room of the foundry and is equipped with four core ovens, with ample room for several others, foundations for which are already in. The core room adjoins the heavy foundry and when the light foundry has been extended further to the west, as will be done later, the core room will lie between the heavy and light foundry, just as does the cupola room at the present time. To facilitate the delivery of cores to the heavy foundry and at the same time provide for a core room entirely apart from the foundry proper, the core ovens are so situated that they form the separating wall between the heavy foundry and the core room. The ovens for the larger cores are made with doors at both ends. This enables the core-oven cars to be wheeled into or out of the ovens either from the core room or from the foundry, as required, and cores may thus be placed on the cars in the core room, pushed into the oven to bake, and then pulled out through the other door into the foundry for delivery.

In the full-page engraving on the opposite page are shown details of construction of one of the two larger ovens. Extending in front of all the ovens is a large pit about seven feet deep, giving convenient access to the furnaces below. The pit is covered with an iron grating. In the two upper views in Fig. 5 this pit is indicated and the general arrangement of the furnaces is clearly represented. The lower of these two views and the group of smaller ones at the bottom of the page are sectional views taken along the various lines lettered to correspond in the upper view. A study of the different sectional views will give a clear idea of the details of design of these ovens. The section on *HH* is a longitudinal section through the furnace and shows also a horizontal flue leading from the furnace back to another horizontal flue at right angles to it, which latter connects with two short uptakes that convey the heat and gases to the core oven. The section on *EE*, in the lower right-hand corner, shows the two uptakes and the flue leading to them.

To carry the gases away from the ovens there are two channels in the floor, one on each side, which connect with a channel in the rear leading to the stack. These channels are covered by iron plates, and by removing one or more of them the size of outlet of the stack is readily controlled. This plan of two channels, one on each side of the oven, ensures very even distribution of heat in all parts of the oven

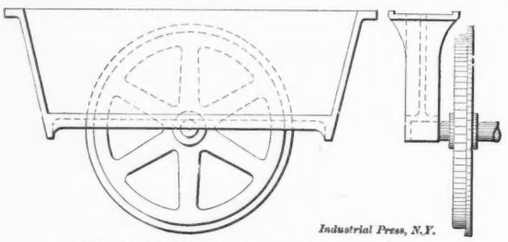


Fig. 4. Anti-friction Bearing for Oven Cars.

and the manner of adjusting the openings to them gives absolute control over the oven temperature. At the top of the ovens are dampers opening directly to the stack. (Fig. 6.) These allow the gases to pass off when the oven doors are open and also ensure a direct draft when starting up the fires. In practice, however, it is found necessary to use the dampers but little.

The cars used in these ovens have the anti-friction "barn-door" type of bearings for their wheels, which have already been described in a previous number of MACHINERY, and are shown in Fig. 4 herewith. The journals on the ends of the axles simply roll along the flat under surface of the supporting brackets of the car, whenever the latter is moved backward or forward, just as in the familiar "frictionless" arrangement of rolls for sliding doors, which require no oiling.

The oven shown at the right in Fig. 3 is designed to afford

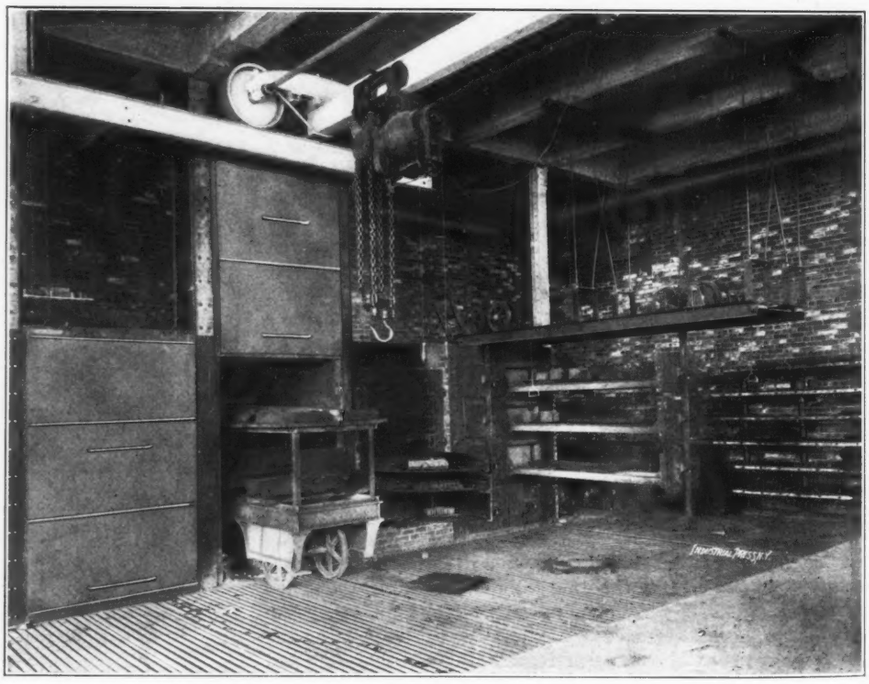
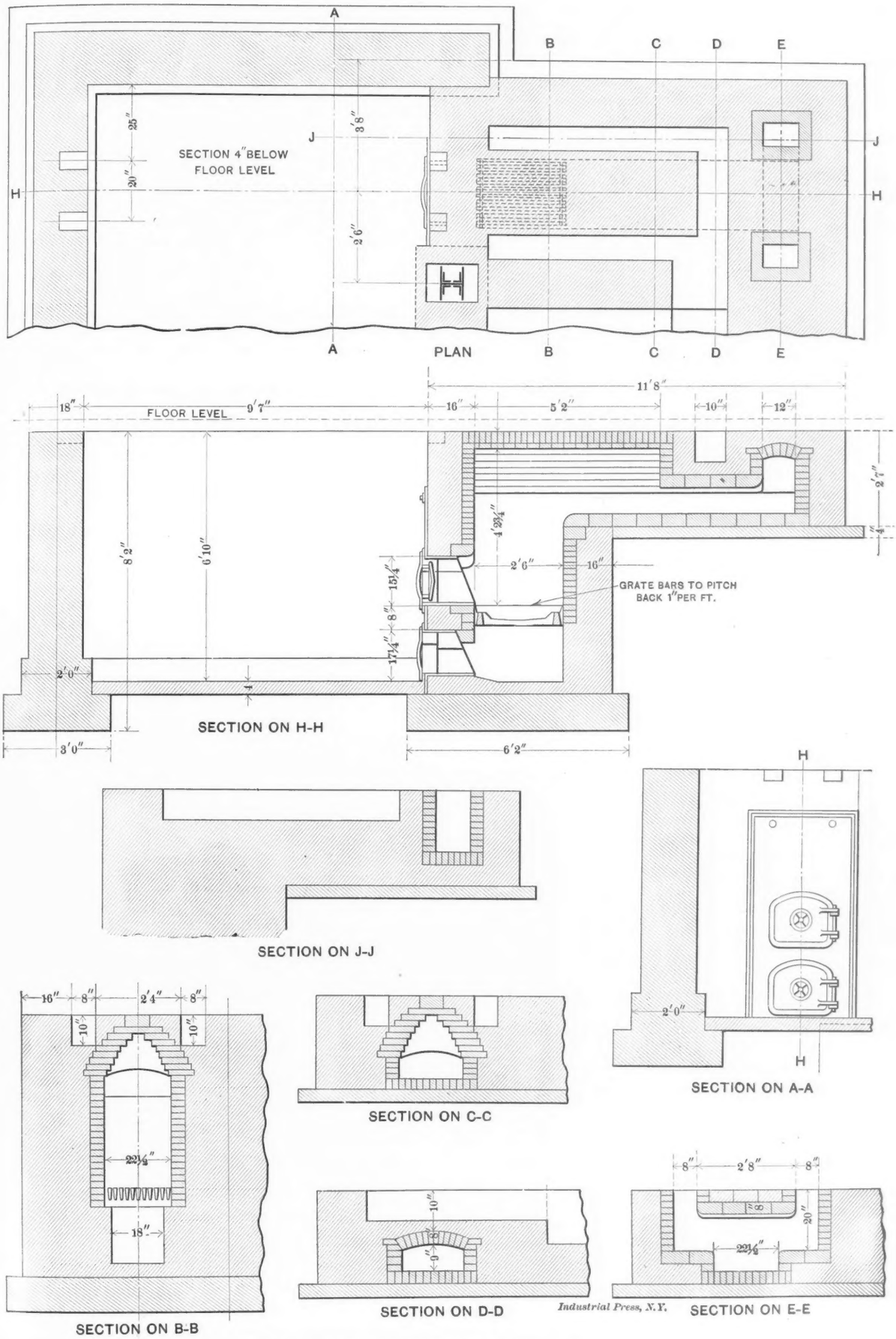


Fig. 3. View of Core Ovens, showing Cars and Racks partially withdrawn.

ample room for a large number of cores and at the same time provide means for withdrawing or renewing a few or as many of them as desired, without disturbing the whole oven. This oven is modeled after similar ovens used by the Singer Sewing Machine Company, Elizabeth, N. J., and the Walker & Pratt Company, Boston, Mass., but is of improved design and is so novel as to be of general interest.



Industrial Press, N.Y.

Fig. 5. Details of Construction of Large Core Ovens.

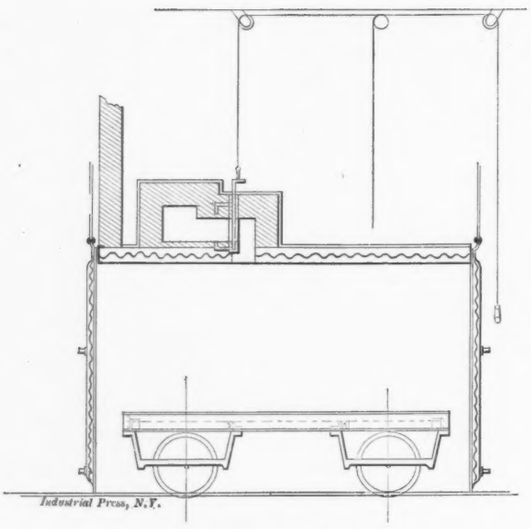


Fig. 6. Showing Damper at top of Oven.

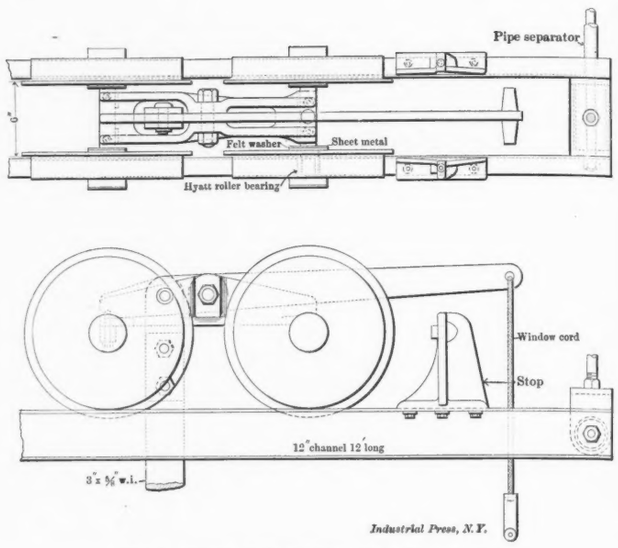


Fig. 8. Trolley used for Supporting Core Racks.

There are eight horizontal movable racks in the ovens, shown clearly in the longitudinal section in Fig. 7. These racks are ranged one above the other, and are supported by wheels and axles so that each rack is virtually the same as a car running on tracks. At the rear of each rack is a pair of wheels running on tracks within the oven, but it would obviously be very inconvenient to have these tracks extend out beyond the front of the oven for the support of wheels on the front of the racks when the latter are withdrawn from the oven. Tracks extended in this way would obviously be very much in the way and would make the oven very inaccessible. To overcome this difficulty and at the same time provide for the support of the forward end of the racks when they are to be withdrawn from the oven, there is an overhead trolley running on an overhead rail, and having a bar extending downward which may be connected to the forward end of any of the racks, enabling it to be rolled out or in. In Fig. 7 the racks *A*, *B*, and *D* are in place in the oven and rack *C* is withdrawn. The trolley supports the forward end of the rack *C*, by means of the rod *R* and a sliding bolt which passes through a hole in the rod and holes in corresponding lugs in the front face of the rack. The bearings at the rear of the racks are the same type of anti-friction bearings used on the cars in the large ovens, and give excellent satisfaction in places where the heat is liable to cause inconvenient expansion or to destroy the lubrication necessary on bearings of the ordinary type.

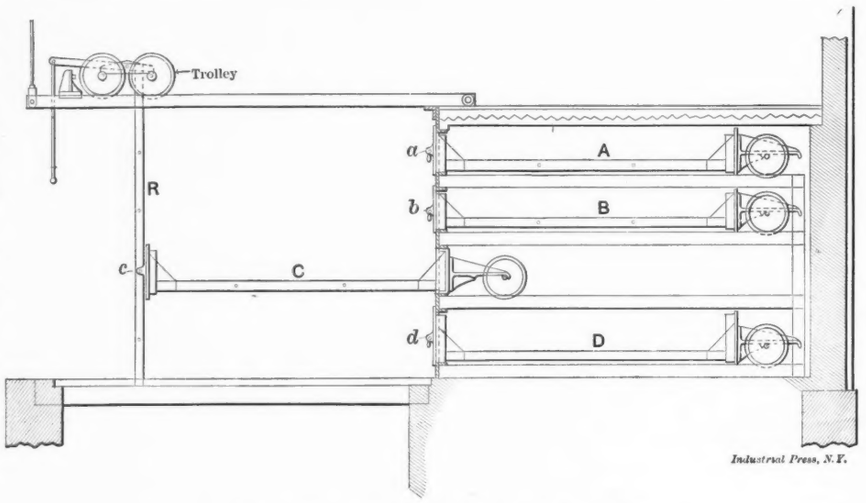


Fig. 7. Section of Oven shown at the Right in Fig. 3.

In Fig. 8 is a detail sketch of the trolley for supporting the

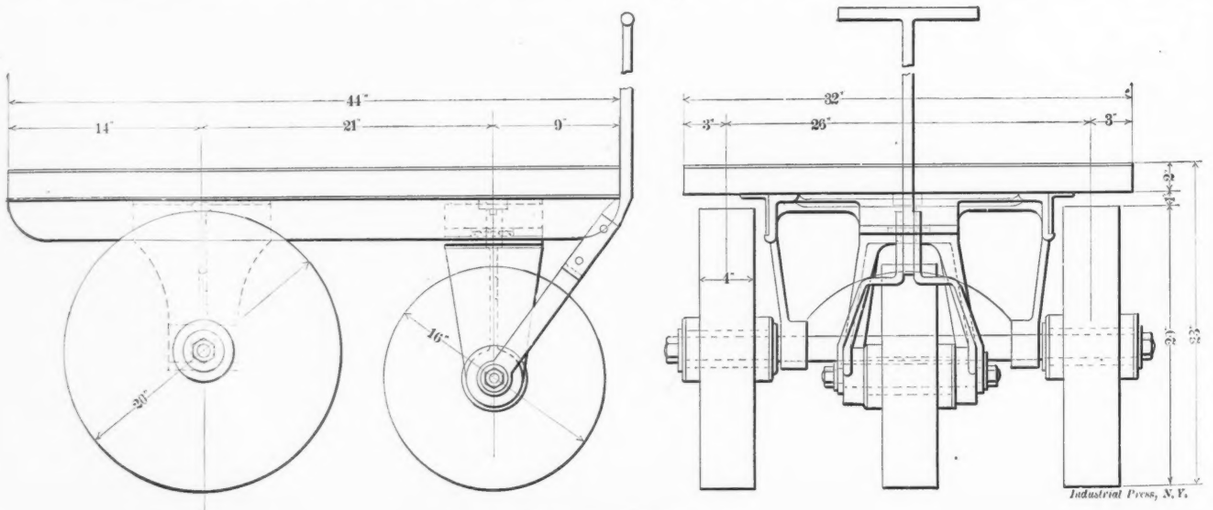


Fig. 9. Charging Car.

forward ends of the racks. The trolley has four wheels, with journals running in roller bearings. The bar by which the racks are suspended is supported by one end of a horizontal lever and by means of which the bar can be raised slightly, through a handle suspended from the long end of the lever. In operation the vertical bar is bolted to the particular rack it is desired to withdraw, and the handle attached to the forward end of the horizontal lever is pulled down. This raises the forward end of the rack from its seat and then by pulling forward on the handle, and on the bar, if necessary, the rack is easily drawn out, and by a similar operation can be rolled back into the oven.

Attention will be called to one other foundry appliance to be found here, represented in Fig. 9. This is the charging truck for the foundry cupolas and similar trucks are also used about the foundry for other purposes. They have frames of rolled shapes and wheels with wide flat treads. The journals have roller bearings and a load of pig or scrap iron is easily pulled into position on the charging floor on one of these. The weight of each truck is marked on the truck in plain figures, so that by weighing the car and charge together and deducting the marked weight of the former, the exact weight of the charge may be determined.

Throughout the foundry dependence is placed on broad iron trackways on which cars of this description can run, rather than on any form of industrial railway. Cars on this system run easily, and can be taken to any part of the works if necessary for loading or unloading, without regard to whether a track runs to that point or not.

* * *

A GERMAN WORM MILLING MACHINE.

ROBERT GRIMSHAW.

The photograph and drawing shown in Figs. 1 and 2 illustrate a machine of German design that is intended for milling simple, double or compound worms and small spiral gears, both right and left hand. In order to mill worms that are made integral with the shaft the spindle of the dividing head is made hollow, allowing the shaft to be passed through so as to bring the worm close to the head. The other end of the shaft is supported by an auxiliary bearing which is also placed close to the worm. On the front of the column is a slide which carries the dividing head and the outboard bearing for the worm arbor, while at the rear of the column on a dovetailed slide is mounted the carriage carrying the cutter. This carriage obtains its motion, when the worm is rotated, by a leadscrew and change gears from the forward feed gear at a rate corresponding to the pitch of the worm. The cutter arbor has its bearing on a swiveling head which, by the aid of a crank, can be adjusted to the angle suitable to the worm pitch. A four step pulley, shown at the left hand side, drives a splined shaft extending the whole length of the machine. From this, by means of beveled gears and a set of spur gears, the general driving motion is conveyed to a shaft lying in the axis of the swiveling plate and from this shaft are driven two worms which simultaneously drive the worm wheel on the cutter arbor. By this arrangement four speeds of the cutter are obtainable, ranging from 15 to 40 revolutions per minute.

The feed is obtained by means of five-step pulleys and a double set of change gears so that there are ten feed speeds. By means of a clutch the feed motion can be thrown out either by hand or automatically at any point. The dividing head is driven from the feed gears by means of a worm and set of change gears. These change gears must be so proportioned as to give a complete turn to the dividing head while the cutter head is traveling the length of the lead of the worm being cut. The depth of the cut is adjusted by an index plate on the screw which controls the cross motion of the dividing head slide, while a stop prevents too deep cutting. By means of a templet or gage that can be attached to the center of the swivel plate the cutter can be brought exactly to position. The machine has a capacity for cutting worms up to 13.8 inches in diameter with a threaded length of 17.7 inches. The builder is Reinecker, Coblenz, Germany.

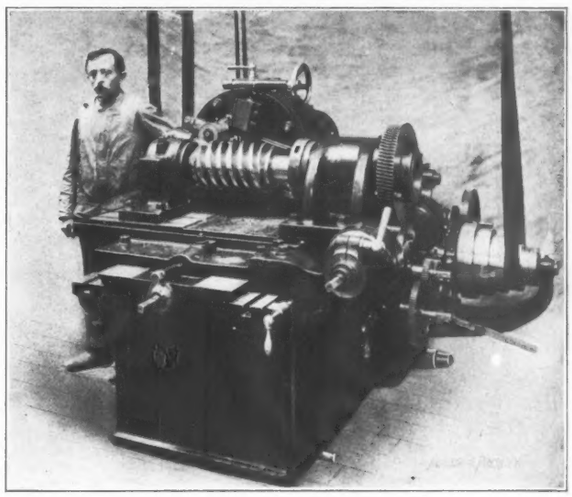


Fig. 1. German Worm Milling Machine.

* * *

The expense of sending out a competent mechanic to set up and explain the working of certain classes of machinery, is in many cases, a heavy item to the manufacturer who is, of course, obliged to count it in the selling price of his product. With some kinds of apparatus it is impossible to do otherwise than send a man along, but the camera is now being used to quite an extent as a setting-up instructor, and there is undoubtedly a much wider field for its use than is now cultivated. An instance of the liberal use of the camera to explain the set-up and use of a machine recently came to our notice. A certain firm make a machine for bending rails for railway frogs and switches. There are a large number of combinations that can be effected for different classes of work, angles, etc., and to explain them so as to render needless the sending out of an instructor, a number of views, thirty-seven in all, were taken showing each and every operation. Half-tone cuts made from the photographs were printed in a pamphlet with simple instructions for each operation. While the initial cost of such a pamphlet is comparatively heavy it requires the traveling expenses of but few trips to balance it. Besides, there is the great advantage to the purchaser of having plainly illustrated instructions always at hand where they can be referred to when occasion demands.

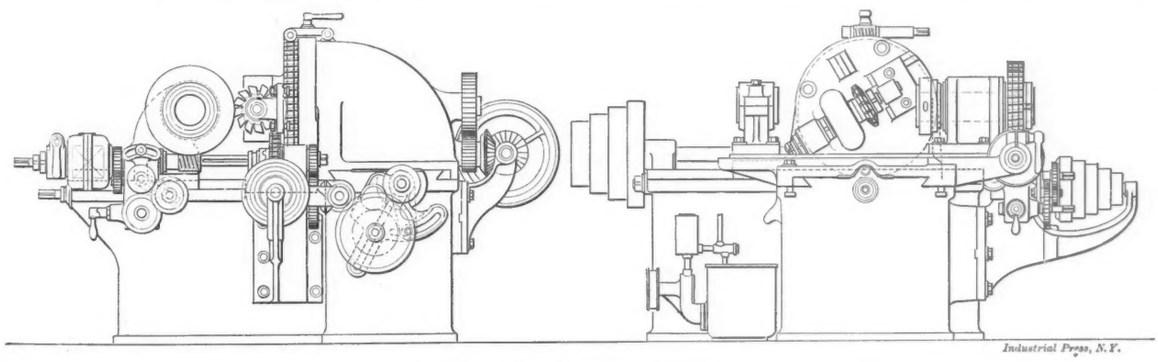


Fig. 2. Side and Front Elevation of Milling Machine.

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SAFE CRACKING AS A FINE ART.

It is a strange but undeniable fact that some of the best machinists and toolsmiths have been notorious safe crackers. That lawbreakers of this class are wideawake and quick to avail themselves of the advantages of new discoveries which may be perverted to unlawful ends, is well known. The battle between the safe makers and the safe breakers has been waged with a persistence almost equal to that between armor and ordnance. When the safe maker finally succeeded in making safes of chrome steel plates that could not be drilled, the safe breaker simply blew the doors off with nitro-glycerine. Then the safe doors were made to fit so tightly that the nitroglycerine could not penetrate into the crack around a door under ordinary conditions. But even with the most perfect construction a crack exists around every safe door and a film of powerful explosive, be it ever so thin, will do the business if it can be gotten in place. To overcome the difficulty the safe breaker simply knocked the handle off the door, applied the nozzle of an air-pump to the opening and pumped the air from the interior. The atmospheric pressure forces the nitroglycerine into the crack—a small quantity, it is true, but sufficient for the purpose.

At last when the safe maker had succeeded in making a safe upon which the last described nefarious practice could not be practiced, thermit made its advent. The criminal class recognized the value of this strange compound long before the average honest man even knew of its existence. One of the amusing experiences of the American representative of this German product, was the receipt of a $1 bill from a convict in a State prison, with the request for a sample of what he had recognized to be an ideal means for overcoming the resistance of hardened steel. Needless to state his money was returned and the order unfilled. The safe makers are greatly concerned regarding the possibilities of thermit as affecting their industry, and not without good reason. The article upon thermit which appeared in MACHINERY several months ago attracted widespread attention and brought many inquiries to this office, among them being two from prominent safe builders who wished to investigate the subject.

In a lecture on radium and similar substances, selenium, etc., delivered by William J. Hammer before the American Institute of Electrical Engineers, April 17, he referred to thermit and said: "I have seen steel safes in which enormous holes had been burned by employing thermit, and it would be possible for a burglar to carry some thermit in his pocket and burn a hole in a safe large enough to insert his arm and extract the valuables. I saw in Germany last summer a substance called 'anti-thermit' which it is intended to place in the lining of safes to prevent the reaction taking place, thus protecting the safe." Mr. Hammer then suggested that a selenium cell could be used for the purpose of sounding a burglar alarm the moment light was admitted to the interior of the safe, etc.

* * *

COMBINING PRACTICE WITH EDUCATION.

Union College, situated at Schenectady, N. Y., in the city where the main works of the General Electric Company are located, is one of the venerable institutions of learning. It not only was one of the first to be founded as a classical college, but was one of the first to take up scientific and technical education, being superseded in the latter respect only by Rensselaer Polytechnic Institute at Troy, N. Y., and possibly one or two others. An engineering course was established in 1843, and in 1895 was added a department of electrical engineering.

It is now reported that an arrangement has been made with the General Electric Company whereby a school for engineering has been organized in connection with the college that will be unlike any other that we know of. Mr. Steinmetz, the famous mathematician and electrical engineer of the General Electric Company, will be the director of the school, with R. Neil Williams, a young Californian who has just returned from a course of scientific work and study abroad, as his principal assistant. The first class is now at work and seventy applications have already been received for the freshman class of next term. Lectures will be given by employees of the General Electric Company and the practical application of principles will be demonstrated, not only in the class rooms but in the General Electric Company's shops. In the summer those of the students who wish to pursue their inquiries further will put on overalls and go to work in the shops of the company.

This is the first instance in this country of a technical school which gives degrees, becoming associated with a large manufacturing establishment, and is undoubtedly a step in the right direction. It is substantially the plan advocated by Prof. Sweet many years ago in a discussion on technical education and will be of particular interest to members of the American Society of Mechanical Engineers who had the pleasure of visiting Union College and its grounds during the recent meeting at Saratoga.

To the outsider, Union College does not appear to be on the top wave of prosperity. Its buildings are mostly very old, and as an institution it does not have the up-to-date look of many other colleges. But if the plan now projected can be carried out, it will nevertheless have taken a very progressive step and its course in electrical engineering ought to become one of the most popular in the country. Students of electrical engineering will here have relatively the same advantages that will doubtless be enjoyed by students in metallurgical subjects at the great Carnegie Institution to be established at Pittsburg. Why should not the idea be carried still further? Why should not students in mining be educated under the auspices of one of our great mining companies? Hospitals are founded, ostensibly for charitable purposes, but frequently with the principal object of affording practical training for medical students. Law schools are established in cities where court practice can be studied. Boys in agricultural schools have to farm it. It is also in accord with modern ideas that a school of engineering should be intimately associated with workshops where students may have free access and not only gain practical experience through observation, but through practical work as well. Only a manufacturing company of large size could well carry out such a scheme and the objection might be raised that they would try to use the students in a way to make the most money possible from their services. Probably they would do this, but the student would be acquiring experience all the time and that is the thing most needed by him.

NOTES AND COMMENT.

A striking example of delicacy in weighing has been referred to by J. A. Brashear, the widely-known instrument maker. At the International Bureau of Standards near Paris is a balance mounted in a vacuum in a heavy glass case, and provided with mechanism for handling the weights from a distance great enough to give security against influence of the heat of the body. So perfectly made are instrument and accessories that when two kilogramme weights are placed side by side on each pan the indicator finally comes to rest at zero. But when one of the weights in one pan is placed upon the other the indicator shows the opposite pan to be slightly the heavier, the almost incredible explanation being that one weight is made lighter by its slight increase of distance from the earth's center. This is delicacy indeed—if true.

In the April, 1901, issue an immense stone turning lathe was described which was built in Philadelphia for turning and polishing very large granite columns at Vinalhaven, Me. As subsequently recorded the attempt to turn and polish these columns, which were about 54 feet long and 6 feet diameter, terminated in failure, two or three of the columns having broken in two during the polishing process. Strange to say no attempt seems to have been made to steady-rest the columns, the immense weight (about 140 tons) having been supported entirely from the ends. So the original plan of the architect to make the columns monoliths was abandoned, and instead they are made in two parts, 36 feet and 18 feet long, respectively. Two of the columns, *i.e.*, two 36-foot and two 18-foot pieces, with their pedestals, have arrived at New York and are now in process of transportation to the site of the cathedral St. John the Divine on Morningside Heights. The larger pieces weigh over 90 tons and the smaller ones about 40 tons each. The value of each column with its pedestal is placed at $25,000.

HOW IS THIS FOR A HOWL?

We have just learned a thing that some have often feared would come to pass—that the British Isles no longer have existence. The news is American in origin, so that there can be no doubt as to its truth. Furthermore, the British colonies are very much in evidence, but they are bereft of the motherland, and are led to seek shelter under the wings of the U. S., for all the world like an old clucking hen calling another's chickens together. We do not read this statement in so many words, but the Pennsylvania Steel Co. has had the audacity to send us a copy of its map of the world with the British Isles deleted—lost in the recent rains perhaps? A couple of years ago it supplied the Gokteik Viaduct in Mandalay, and lets the world know all about it in an illustrated *brochure*, "From Steelton to Mandalay," a sort of characteristically Yankee "lick-creation" story. The map shows the route followed in the conveyance of the construction from Steelton Works to its destination, and while it shows such places as Iceland, Tasmania, Madagascar, and many even less important places, it wipes out these poor little islands as with a sneer of contempt. It is the kind of insult that some indiscreet U. S. traders are committing every day in their excessive pushfulness. We should like to think that the omission was only an error, but it is too strange and remarkable for that. The incident may afford our manufacturers some little amusement, though it is an exceedingly poor joke if such it is intended to be.—(London) *Electrical Review*.

JERUSALEM THE GOLDEN.

An engineer who has been traveling in the Holy Land contributes a paper upon his trip to the Engineering Association of the South in which he rather shatters the golden features that we are accustomed to associate with the city of Jerusalem. He says:

The most remarkable feature of the city, from the engineer's point of view, is the total absence of all the blessings associated with good engineering. Pure, clean water, the one good thing above all others to be prayed for in the Orient, is more scarce now than in the time of the Jewish kings. Now, as then, water is carried in goatskins, on the backs of men, women, and donkeys, from Siloam's pools up a steep, dusty road, one-half mile, to the streets of the city, and there retailed by the gallon; but the aqueducts that, in ancient days, carried water from Solomon's pools and springs, about fifteen miles south of the city, are in ruins. The dull, heavy hand of the Turk rests, as a curse, over the country. There are no sewers, no street lights or fire department, and the refuse from the streets and back yards is, not very efficiently, carried off in baskets on the backs on donkeys. The patient, gentle, frugal little donkey is in evidence everywhere. Women, children, and big, heavy men straddle his back; he carries up steep, rocky hills burdens much heavier and bigger than himself, and you see children pet him and play with him in the back yards as our children do with their dogs, and he is invariably treated gently and kindly by his owner.

HIGH-SPEED PLANER WORK.

The reference to high-speed planer work done in the Juniata Shops of the Pennsylvania R. R. at Altoona, Pa., was in error in stating that Bement, Miles & Co. were the builders of the frame planer which is being successfully operated at a cutting speed of 40 feet per minute. The Pond Machine Tool Co. are the makers of this machine. Further particulars recently received regarding the work done are interesting. A pair of locomotive frames for the class of P. R. R. freight locomotive known as H6, are planed and finished in 16 hours. These frames are of the four-pedestal type, 27 feet long, 30 inches wide and 4 inches thick. It is thought that this beats the record for frame planing in any locomotive building shop.

A test was recently made to determine the power required by a 72-in x 72-inch Pond cylinder planer running at a cutting speed of 35 feet per minute and working on four cylinders of the E3a type weighing 3,700 pounds each. The machine is driven by a 30 H. P. General Electric motor of the CL type. Two tools were cutting, one tool taking a chip ½ inch deep, feed 3-16 inch and the other 3-16 inch deep and ⅛ inch feed. The power required when cutting was 18.3 horse power; to reverse the platen at the end of the cut 70.7 horse power; to return, 7.3 horse power; and to reverse for the cut, 47.1 horse power. It is expected that 35 feet cutting speed will be adopted in these shops as the standard for planer work.

* * *

DEATH OF I. MC KIM CHASE.

Isaac McKim Chase, M.E., of Washington, D. C., whose name and writings have frequently appeared in this journal, died of tuberculosis at Atlantic City, N. J., on June 7. He died as he wished to do, with armor on, still fighting. His latest contribution to MACHINERY appeared in the June issue. Mr. Chase was born in Baltimore, Md., May 27, 1837—an American of Americans, being a descendant, through his father, of William Chase, who came to America with Gov. Winthrop in 1630; and, through his mother, of the Silver and Crusee families of Revolutionary prestige in New Jersey. Mr. Chase's entire career was consistent in developing his natural mathematical and mechanical genius. He received a thorough training in drawing and marine engineering, and always proved competent to cope with important and difficult problems. His chief life work was in the Washington Navy Yard as foreman of Pattern Department, to which he was first appointed in 1861. His recognized ability caused his selection from time to time for work requiring special qualifications. He was sent to Europe in 1878—the time of the Paris Exposition—with a device for signaling, which has since been adopted by the French and Russian governments. He gave up his position in the Navy Yard for several years to design the Lanston typesetting machine, for which he predicted a great future. This work brought him a diploma from the Columbian Exposition in 1893. Mr. Chase returned to his post in the Pattern Department and remained there until his death, developing and enlarging the scope of the Washington yard, and making work possible there that had previously been of necessity done elsewhere.

Mr. Chase patented many devices, his latest in 1902 being a screw-propeller, from which much is expected. His contributions to the literature of mechanical engineering and pattern-making have been numerous and valuable. His book on "Screw Propellers and Marine Propulsion" (published by John Wiley & Sons) has had a large circulation, and has recently gone into another edition. His latest work, "The Art of Patternmaking," by the same publisher, is now in press, and its publication is anticipated by those interested in this subject as almost the final word along this line in which his experience was practically unlimited.

POWER PLANT WITH NOVEL FEATURES.

UTILIZING THE WATER OF CONDENSATION AND THE CONDENSING WATER.

GEO. L. FOWLER.

In the remodeling and enlargement of the repair shops of the Chicago, Milwaukee & St. Paul Railway, now in course of execution, some novel and interesting features are to be introduced, based upon the past experience with the power plant

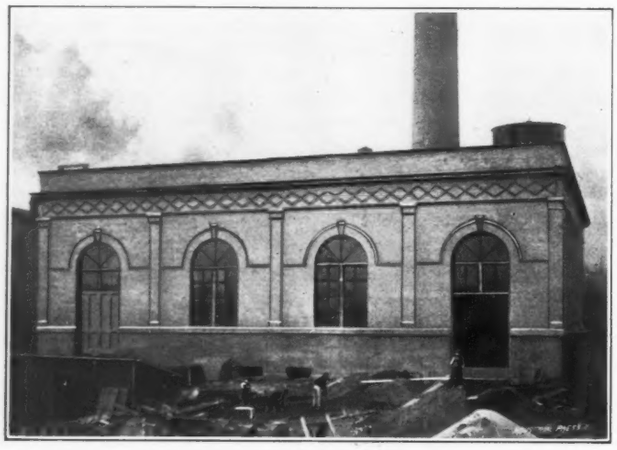


Fig. 1. Exterior of Model Power House at the Milwaukee Shops of the St. Paul Railway.

heretofore used for driving the car shops. As in all of the large railroad shops that have grown from comparatively small beginnings, there were necessarily a number of small and independent power plants for the service of the several departments. Of these that of the car shops was the largest, then came the machine shop, followed by smaller installations in the foundry, small planing mill, roundhouse and the like.

With the new power house all of these separated plants, with the exception of that of the car shops, which will be retained, will be concentrated in one, and in this a valuable principle of operation will be borrowed from the older one.

The car shop engine is a cross-compound Corliss engine of about 275 horse power that is ordinarily worked condensing. The water of condensation is obtained from an artesian well, which is forced to give a sufficient flow for the purpose by means of an air jet carried down to the bottom of the pipe. Ordinarily this water of condensation is turned into the sewer as soon as it has done its work with the engine. Here, however, it is saved and stored in a large cistern located next the machine shop and from it is drawn the supply of water used for washing out the boilers in the roundhouse.

The water itself is not altogether suitable for boiler purposes, but answers admirably for the work done with it. In this way the economical advantages of working the large engine with a condenser are obtained, coupled with that of the use of hot water, which it has cost nothing to heat, for washing out the locomotive boilers in the roundhouse.

The water used at West Milwaukee for filling the locomotive tanks is from Lake Michigan, and is obtained from the city on meter measurements, about 600,000 gallons being used every twenty-four hours. In designing the new plant advantage was taken of the fact that this large quantity of water would be required for the locomotives, and arrangements have been made for first utilizing it as a condensing water for the engines in the new plant. Accordingly a large standpipe capable of holding about 300,000 gallons is located near the power house. It can be seen projecting above the roof of the same in the half-tone reproduction of the photograph. The water is taken from the city mains, used for condensing purposes and then pumped into the water tower, whence it is drawn off to fill the tanks of the engines.

The temperature of the lake water runs from 50 to 60 degrees and with it a vacuum of from 27 to 28 inches can be maintained at the engine. If at any time it should be found that the condensing water reaches the tank of the locomotive at so high a temperature that the injectors will not work, the vacuum will be lowered and water of a lower temperature be sent to the locomotives. Here, too, there is a two-fold saving, in the possibility of working the engines condensing and the use of hot water on the locomotives.

Turning now to the details of the power house, it is of the yellow Milwaukee brick and of a pleasing architectural design, as indicated by the photograph. In plan it is nearly square, measuring 97 feet by 100 feet, with a clear height of

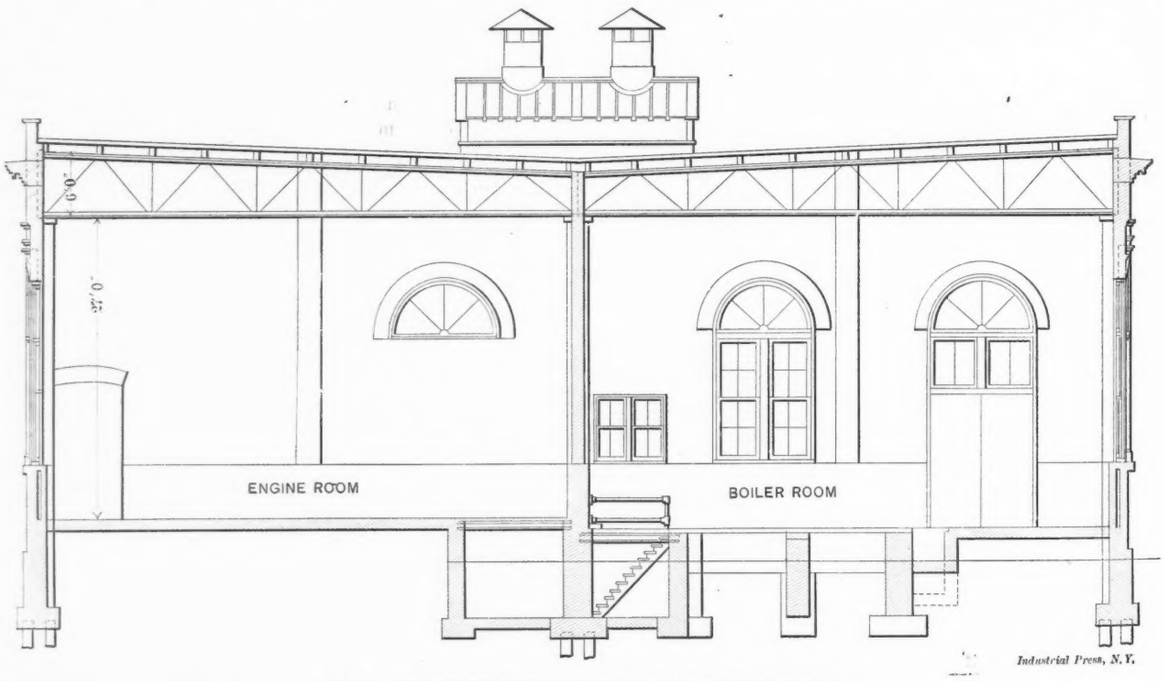


Fig. 2. Cross-section of Power House showing Roof Construction.

27 feet above the floor of the engine room to the bottom of the roof girders. It is divided into two nearly equal parts by a brick wall which thus separates the engine from the boiler room.

At one end of the engine room there is an extension of 16 feet in which are located the pump and condenser rooms.

The boiler equipment, as at present laid out, consists of two batteries of Babcock & Wilcox water-tube boilers, with a total rated capacity of 1,200 horse power. Space is also provided

for the installation of a third battery, so that the ultimate capacity will be 1,800.

In the engine room there are two Nordberg cross-compound engines with 15-inch and 26-inch cylinders and a piston stroke of 36 inches. Here, too, space is left for a third engine of the same size. Each of these engines drives a 200 kilowatt generator built by the Milwaukee Electric Co. In addition to the two large ones there is a 160 horse power Westinghouse engine driving a 100 kilowatt generator.

As in all modern railroad shops compressed air is extensively used for a great variety of purposes about the premises, a compound Allis compressor with air cylinders 13 inches and 22 inches in diameter, and steam cylinders of 14 inches and 26 inches, with a common piston stroke of 36 inches has been installed.

In the pump room there is a wash-out pump with a capacity of 600 gallons, and a fire pump of 4,000 gallons per minute. The condenser room contains a Cochrane feed-water heater, a Wheeler surface condenser and the boiler feed pump.

The stack stands clear of the building and is 9 feet inside diameter.

The illustrations that are given of the building show its appearance and the arrangement of the machinery very clearly, the characteristic feature of which has already been elaborated. In regard to the distribution of the power in the shops, that will be taken up in a future article.

* * *

FRICTION TEST OF OILS.

ARTHUR W. COLE.

In the operation of shafting and machinery, there is always a great loss of power on account of the unavoidable friction in the numerous bearings. The manufacturer is therefore constantly striving to lessen this loss by reducing to a minimum the friction between all the moving surfaces. The most common means of doing this is to introduce oil or grease into the bearings in order that the rubbing surfaces may not come

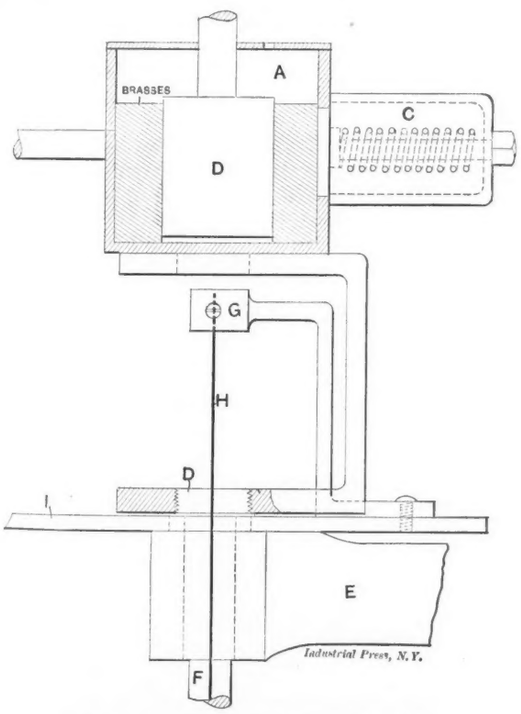


Fig. 1. Section through Oil Testing Machine.

together, but will be separated by a very thin film of the lubricant. At the present time the use of oil is being replaced, in a measure, by boxes lined with graphite and also roller bearings. The use of oil, however, will never be wholly superseded by these more modern methods. The great difficulty in using oil is to determine exactly the proper one to be used in the bearing in question. Until within a very short time, there has been no means of accurately determining the value of an oil for reducing friction. The only methods of determining this property have been the comparatively crude ones of the viscosity pipette which is used by the Pennsylvania Railroad, also by the feeling of an oil when rubbed between the fingers and by actual test in the bearing of which it is to be used.

Without doubt the long-felt want of a better and more accurate method of the determination of the value of an oil will soon be filled by the very simple but ingenious machine which has recently been completed by one of the Professors of Mechanics in an eastern Institute of Technology, by the aid of which the writer obtained the results contained in this article. In this machine an ordinary 14-inch sensitive drill is used for the frame and driving part. The test journal within the cup shown at *A*, Fig. 1, has its axis vertical, and is suspended from the drill spindle by means of a Hooks universal

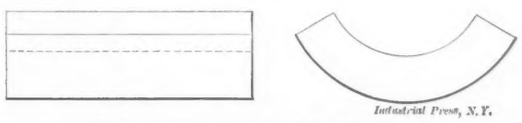


Fig. 2. Brasses used in Oil Testing Machine.

coupling, and runs between two opposing bearings in the cylindrical cup, which may be filled with the oil to be tested. The load is placed upon the bearing by means of a helical spring, contained in the sleeve *C*. This spring has a capacity of about 900 pounds. The tension may be adjusted by means of a screw and is also provided with a device for quickly applying or removing the load without changing the adjustment. The cup *A* has a cover in which is a hole for inserting a thermometer.

The cup and the parts attached to it are carried on a spindle *D*, which is 1⅜ inch in diameter and turns freely in the sleeve supported by the arm *E*, which is attached to the drill frame. The spindle *F* extends nearly two feet below the sleeve, and is suspended from a fixed bracket *G* by a tempered steel wire *H*, passing through the spindle and fastened to its lower end. When the machine is in operation the suspended parts swing freely to such a position that the torsion of the suspension wire balances the friction at the test journal, and the angle of torsion may be read from a graduated disk at *I* by means of a pointer. The suspended parts are counterbalanced by weights, so that there is no pressure of the revolving spindle against the sleeve when the oil in the bearing becomes evenly distributed. The advantage of suspending the apparatus on this steel wire is that, in this way, large indications are obtained for a very small amount of friction at the surface of the journal. In cases where great friction is encountered, a helical spring is placed on the spindle *F*. The cup and the test journal are arranged so that they may be readily heated by a Bunsen burner.

The test journal which is contained in the cup *A* is 1⅜ inch in diameter, of tool steel hardened, ground and polished, The brasses which form the bearing are sectors cut from a brass ring which has been carefully finished, and each has an arc of about 120 degrees, and are about two inches long. The brasses are fitted with great care so that they will cling to the journal when perfectly clean, after the manner of surface plates. Fig. 3, on the next page, is a detail of one of the brasses of the bearing.

It is well to calibrate the machine each time before running a series of tests. By this it is meant that it is necessary to test the torsion of the wire to find its constant or the moment in inch pounds required to twist the pointer through one degree as indicated on the graduated table. The moment is then reduced to pounds acting tangentially to the surface of the journal. This is accomplished by winding cords about the drum, and carrying them over pulleys and placing known weights upon the scale pan attached to the cord. If the diameter of the drum is then measured to the middle of the cord, that is the actual diameter of the drum plus the diameter of the cord, and the diameter of the journal, the length (L) and width (B) of the brass bearings are also measured; the intensity of the pressure is then equal to the total load divided by the projected area, the projected area being equal to BL for each brass. The friction per square inch may then be stated as the total friction divided by the total surface,

the surface being equal to S, the length of the arc times L, the length of the bearing for each brass.

Before starting the test, the oil cup, the journal and the brasses must be thoroughly cleaned. The most effective method of doing this is to wash the parts carefully with kerosene and wipe with a piece of clean waste. The bearing surfaces should be cleaned with special care and should not be touched thereafter with the fingers. Great care should also be used not to scratch or bruise any of the parts. The load should not be applied to the journal until after the machine is started and should be removed before stopping, otherwise the brasses will seize the journal so that it will be very difficult to release them.

When all is in readiness the test machine is started, the oil poured in, and cover containing the thermometer fastened in place. The load is then applied by means of the spring. The revolutions of the journal are noted at the beginning and the end of each run. A small Bunsen flame is then placed under the oil cup so that the cup and its contents may be slowly heated. The reading of the friction is taken by means of the

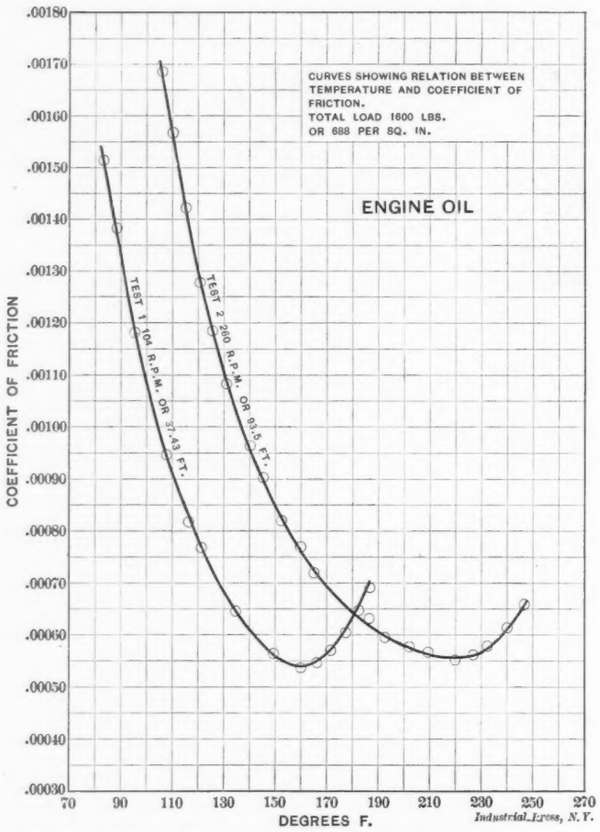


Fig. 3. Relation between Temperature and Coefficient of Friction.

pointer every five degrees F. or two degrees C. rise in temperature of the oil. This process may be carried on until the oil reaches a temperature from 150 to 300 degrees F. according to the kind of oil tested. If the revolutions per minute and also the total load on the journal are known, which may be read in pounds from the pointer on the spring after the manner of an ordinary spring balance, also the temperature of the oil, and the number of degrees twist in the wire, we may readily determine the coefficient of friction of the oil.

It is first necessary to calibrate the wire, and this is done by placing one-pound weights in a scale pan attached to a string wound around the drum as previously explained.

From measurements taken we have:

Diameter of drum	4.138	inches
Diam. of string wrapped around drum	.0245	"
Effective diameter of drum	4.163	"
Diameter of journal	1.3745	"

To calculate the equivalent force, which, when applied tangentially at the surface of the journal, will turn the pointer the same distance that it was moved by the weight in the scale pan, we have the proportion: Force at surface of journal is to the weight in the pan as the diameter of the drum is to the diameter of the journal, or, $\frac{X}{2} = \frac{4.163}{1.3745}$ where X is the desired force at the surface of the journal. From this we find that X or the desired force tangential to the journal's surface is equal to 6.07 pounds, the wire being twisted 155 degrees as indicated by the pointer on the graduated table; therefore the force required to twist the wire one degree is equal to $\frac{155}{6.07}$ or .0391 pounds.

In Test 1, which was run on engine oil, the speed was 104 revolutions or 37.43 feet per minute; total load was 1,600 pounds or 688 pounds per square inch. At 75 degrees F., the spring was twisted through 81 degrees. From calibrating the wire it was found that one degree equaled .0391 pounds, therefore the total friction at the surface of the journal is .0391 times 81 or 3.1671 pounds. From measurements of the journal bearing we find that there are 5.771 square inches of bearing surface, therefore the friction per square inch of bearing surface is equal to 3.1671 divided by 5.771, which equals .548 pound per square inch. The coefficient of friction of the oil is then found by dividing the total friction by the total load on the journal, or 3.1671 pounds divided by 1,600 which is equal to .00198.

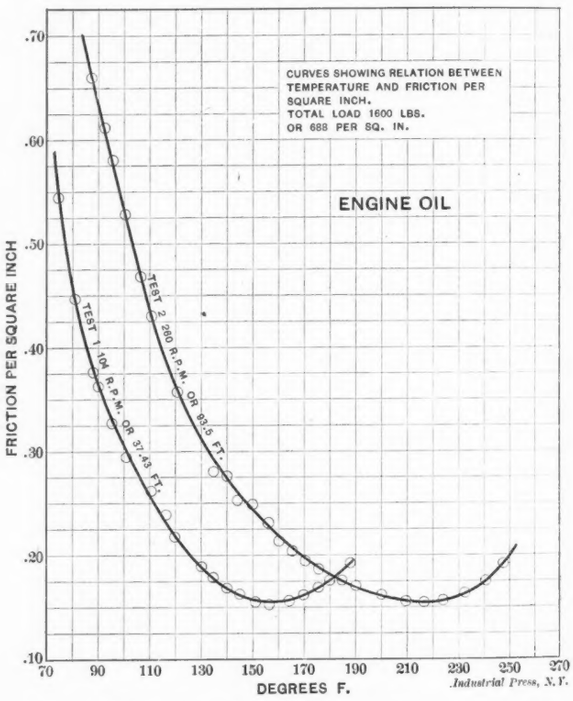


Fig. 4. Relation between Temperature and Friction per square inch.

By a series of such calculations the curves in Figs. 3 and 4 were drawn showing the relation between the temperature and coefficient of friction, and temperature and friction per square inch. From these curves we note that the pressure per square inch and the coefficient of friction vary in a similar manner as the temperature rises. We also notice that the friction steadily decreases for a time as the temperature rises until at last a point is reached where the coefficient of friction increases as the temperature is still further raised. This shows that there is a certain temperature for every oil, which temperature will vary according to the load applied, at which the oil becomes so thin that it can no longer support the load and breaks down, causing the friction to increase rapidly. It is also evident that the nearer the oil can be worked to the temperature at which the breaking-down occurs, the better results will be obtained, in so far as a low coefficient of friction is concerned.

* * *

A French inventor has a method for typesetting by telegraph, thus doing away with the transcription of press dispatches.

PISTONS AND PACKING RINGS.—7.

J. H. DUNBAR.

In response to a request to engine builders for blue-prints, etc., of their pistons and packing, I am able to show a number of pistons as they are made to-day. They are given in the order in which they were received.

Fig. 1 shows the Buckeye Engine Company's (Salem, O.) piston for their 18x30-inch Tangye engines. The spider is evidently cast iron, with flange and follower turned an inch smaller in diameter than the cylinder. The piston is packed with two eccentric rings slightly L-shaped in cross-section, so as to make them flush with the ends of the piston. The rings are comparatively heavy, and not liable to break except in a general smash-up. I don't know what excuse lighter rings have for breaking, but they do break just the same. I suppose the packing rings are turned to the diameter of the cylinder, and then set out as occasion requires, with the six ⅞-inch setscrews, five with flat springs on their outer ends, and the bottom one resting in a counterbore in a plate fitting the inside of the rings. This plate not only makes an excellent joint-cover, but also, by being bolted to a ring at each end, leaving one end of each ring free, makes a good doweling arrangement. Right here it will be seen that if the rings are put in the cylinder as shown in the blue print, there is nothing to stop a leak at the joint. This is no doubt an error in the print, for the Buckeye people believe in keeping all the live steam in one end of the cylinder. In their circular they speak of this as a balanced piston, which I take it means that no steam pressure gets inside of the rings, or if it does it cannot force the rings out, owing to their being clamped in their groove. If the latter, it is practically an adjustable solid head, so to speak. The reader will note that the rings have six inches face, and with this breadth they may be perfectly free in the cylinder, and still not leak appreciably. They will never leak at the bottom, as the weight of the piston will hold them to the cylinder, but I am of the opinion that steam will get between the cylinder and rings part way across their face at the top, and give them a steam load to carry on the bottom. As a whole, the design is a fine one, and will compare favorably with any piston that we shall find. There is nothing to wear out about this piston but the rings, and they are made with a generous amount of stock for that purpose.

The Fishkill Landing Machine Co., Fishkill-on-the-Hudson, N. Y., make their pistons as shown in Fig. 2, having one eccentric snap ring with joint cover riveted to one end of the ring. The ring is not shown to be doweled. The company says of this piston: "The piston is made very strong, and securely fastened to end of steel piston rod. The weight of the piston is carried on a center or junk ring, adjusted by screws in the spider so that it will sustain all the wear; while the spider, follower and packing ring are kept central in the bore of the cylinder. The packing ring is elastic and self-adjusting, forming an effective steam joint with a very small amount of friction, and consequently the wear on it is trifling." Probably a very slight improvement would be made in this piston if the edges of the ring were undercut to give concentric groove wear. This seems to be all that can be said of this piston, except that which applies to it as a type, which will be noted later.

Fig. 3 shows an 18-inch piston for a Williams vertical engine, made by the Quincy Engine Works, Quincy, Ill. This sketch shows their piston to have several features not usually seen—for example, there is no bottoming clearance between the packing ring and the piston body, according to the dimensions given. In my opinion there should be some clearance to compensate for unequal temperatures of packing ring, bull ring and cylinder, which may be considerable, at times, depending upon the carelessness of the engineer. Then, too, with the packing rings solid against the body of the piston they have to guide the piston in the cylinder, while properly the bull ring should do that. A material list furnished with the blue print shows that nine springs are required for each engine. Now it is somewhat difficult to divide nine springs into two equal lots, one lot for each packing ring, and have nothing but whole springs. It takes a resourceful fellow and a blacksmith shop in his vicinity, to make luck out of odd numbers, in cases of this kind. It seems plain that nine springs are needed to each packing ring. These springs which are slightly elliptical, tend to force the rings out to the cylinder, but gibs hooking over lugs on the inside of the rings at their joints, prevent the springs from doing so, very much in the same manner as Prof. Sweet holds his packing rings, which was shown in the sixth installment of this series.

It seems to me that if the radial-acting packing ring springs in Fig. 3 were left out, and a tangent-acting spring put in at the joint, to spread the ends apart, leaving the ring free to vibrate slightly crosswise of the cylinder in its groove, to compensate for any imperfection of alignment due to crosshead or guide wear, the piston would be an excellent one. It is not the intention to imply that the Williams piston is not a very perfect one. The writer has been guided only by a study of the blueprint, in what he has said.

The Fitchburg Steam Engine Co., Fitchburg, Mass., make pistons for cylinders 44 inches in diameter, with bull ring and two snap packing rings, the latter being only ¾ inch wide. While it is unusual to make packing rings of that diameter so narrow, there does not seem to be any good reason for making them wider unless "because the other fellows do" is considered to be sufficient grounds for making the change. Another feature of this design is its simplicity. There is not a piece that can be dispensed with, unless it is a packing ring. The two-ring piston is largely in the majority at present, especially for smaller cylinders, say 20 inches and under, but the single-ring piston is undoubtedly growing in popularity. The Fitchburg piston, shown in Fig. 4, has the lower half of the bull ring babbitted to insure the least wear possible on the bottom of the cylinder. Its large wearing surface will also be noted.

The William A. Harris Steam Engine Co., Providence, R. I., use the Corliss piston, and, I believe, are the originators of the type. They say of their piston: "The packing ring is first made in one piece, and is turned to the exact diameter of the cylinder; it is then divided into sections, and the joints made tight by inserting bronze plates. The ring is pressed outward with German silver spiral springs, one spring being placed under each plate. The groove in the junk ring is turned just deep enough to permit the packing ring to go below the surface. Whenever it is necessary to remove the junk ring the packing ring is held in place with wire pins, pressed through holes for that purpose. The piston head is provided with bronze adjusting bolts, so that the piston rod can be set and kept in the center of the cylinder." The blueprint, Fig. 5, shows their 24-inch piston so clearly and completely, that there need be no further description. We may note, however, that the bottom clearance under the packing ring is only 1-32 inch, an ample amount, showing that details of the least significance are made with reference to requirement rather than precedent.

There are two very distinct types of bull ring pistons. One is the Corliss, where it forms the entire outer part, or shell of the piston, and has grooves for the packing rings, all as shown in Fig. 5. The other is the original Dunbar, invented by Mr. Henry D. Dunbar in 1861, in which the bull ring forms that part of the piston between the packing rings and bottom for grooves. The Dunbar is strictly a two-ring piston, but I have been very successful in making them last twice as long by using one at a time, on the principle that if one ring lasts one year two rings will last two years. The only difference that I can see in the operation, with one ring removed, is that the cylinder clearance becomes very slightly greater at one end than at the other, and a shoulder is worn in the cylinder, marking the end of the ring's travel. The Corliss piston is admirably adapted to a single packing ring, or a "lot of 'em." With a three-ring piston it is dangerous to try to get the middle packing ring to run over the counterbore, even at one end of the cylinder.

It seems to me that a single-ring piston for horizontal engines of the Corliss type, has in addition to its weight, a very considerable steam load to carry. It is expected that the bottom of the bull ring will make a steam-tight joint with the bottom of the cylinder, and that the steam will hold it down as an unbalanced slide valve is held to its seat. With a view to relieve the piston of this steam load, I suggest that the

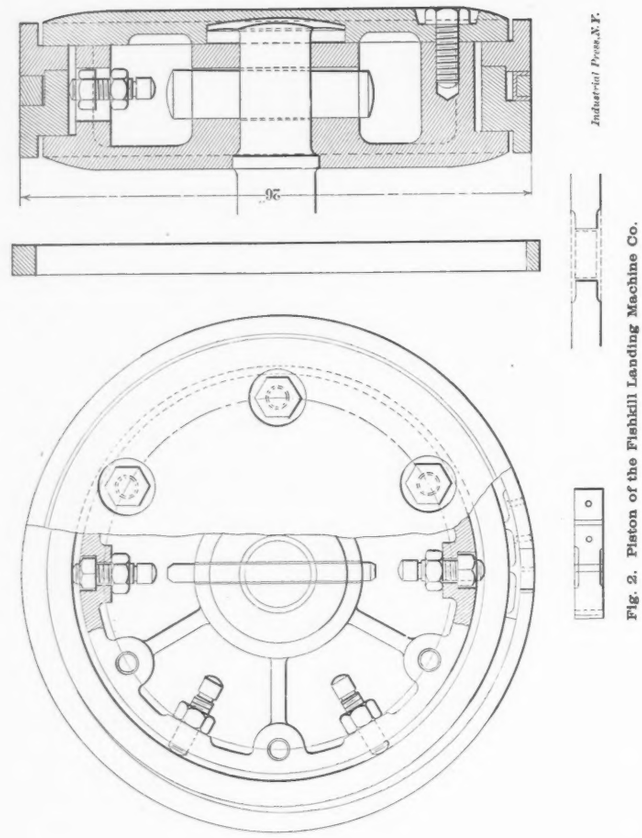


Fig. 2. Piston of the Fishkill Landing Machine Co.

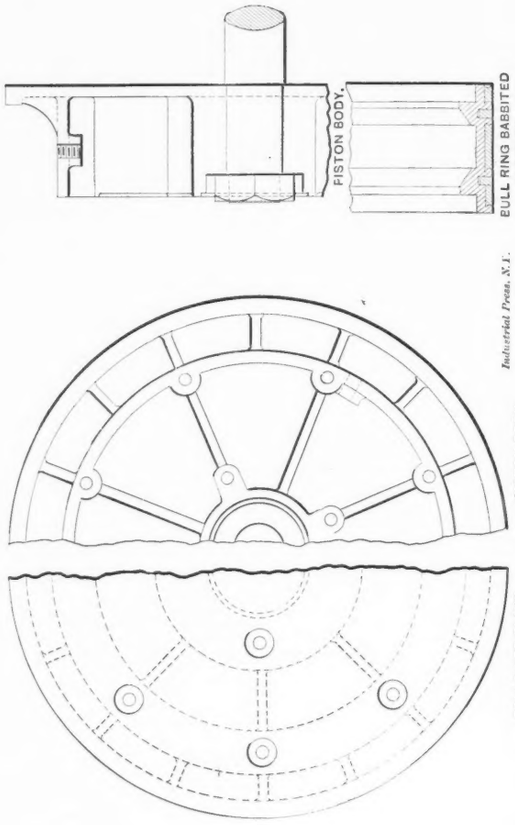


Fig. 4. Piston of the Fitchburg Steam Engine Works.

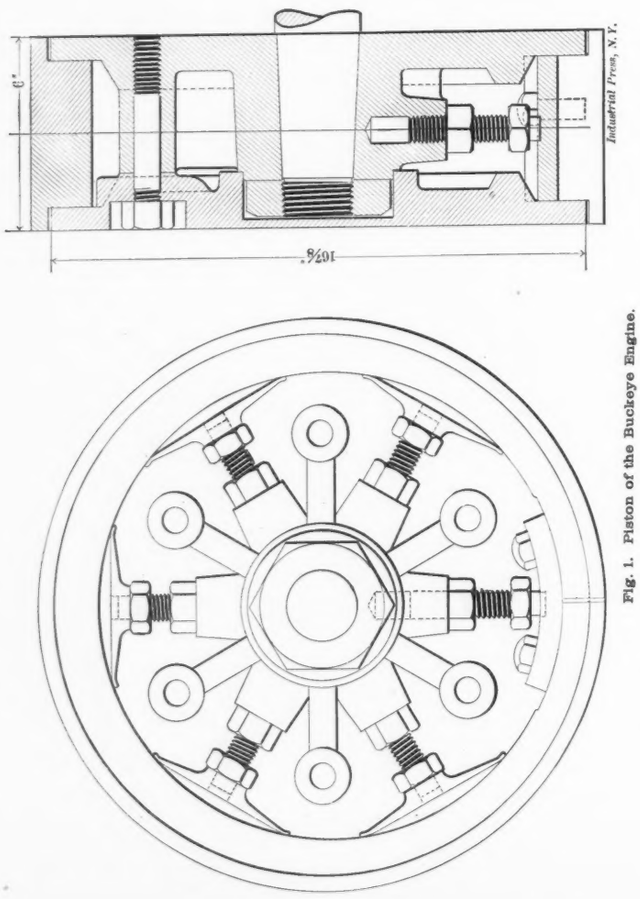


Fig. 1. Piston of the Buckeye Engine.

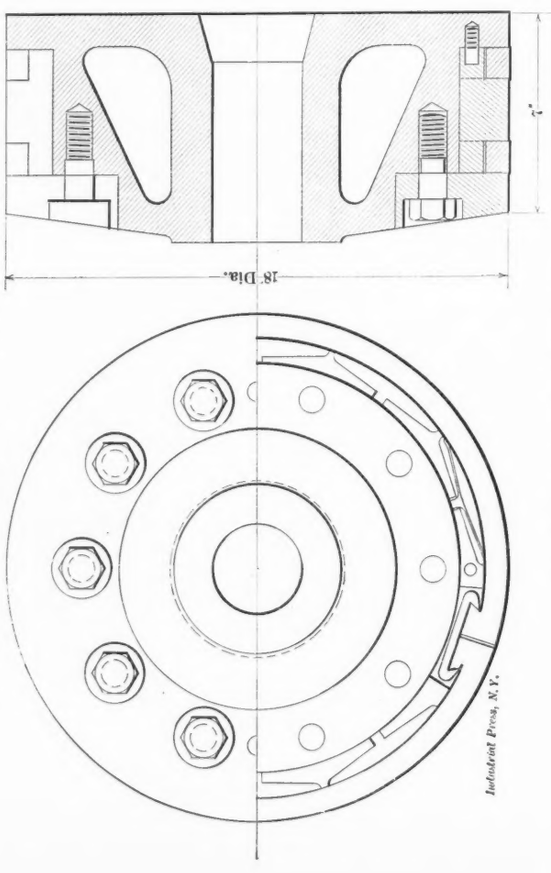


Fig. 3. Piston of the Quincy Engine Works.

bull ring be made with a cavity in the bottom of it, on each side of the packing-ring groove, each cavity equal in area to one-fourth of the entire area of the cylinder in contact with the bull ring. Into both of the cavities in the bull ring live steam is admitted through holes, as shown in Fig. 6. Referring to this figure it will be seen that there is a cylindrical chamber in the bull ring, placed near the bottom of the cylinder, with a valve in it, slightly shorter than the distance between the flanges of the piston. Steam enters the chamber as shown by the curved arrow and passes into both cavities, *C*, as indicated by the vertical arrows. Now assuming that there is the same pressure in the cavities as there is on the piston (and there is no reason why this should not be very nearly the equal) and remembering that the unbalanced area of the bull ring is equal to that of the cavities, it is easy to see that only the inherent weight of the piston can rest on the cylinder. The cylinder may be relieved of a considerable portion of that, by increasing the area of the cavities.

It will be noted that two counterbores are shown at the end of the cylinder in Fig. 6, one for the piston and one for the packing ring. It is quite possible that if Prof. Sweet's limited expansion packing ring is used, no counterbore will be needed for it, there being practically no ring wear on the cylinder. Then, too, without a counterbore to drop into, Corliss or snap rings may be made as narrow as it is practical to make them, for all diameters of cylinders, when the cylinder wear due to the ring will be so small that it may be neglected in properly cared for stationary engines. To illustrate this point take a 24 x 48-inch cylinder, with one packing ring in the piston ½ inch wide, the iron in ring and cylinder to be as nearly alike as possible, then we may expect the cylinder wear to be practically one per cent. of that of the ring. The ring in wearing away 2-10 of an inch in diameter, would raise a shoulder in the cylinder 1-1,000 inch high. It is a question, no doubt, among builders of horizontal engines, in regard to the advisability of supporting their pistons on a tail rod. Higher speeds and steam pressure add to the actual weight of the piston, to increase its strength, and also a greater steam load to carry; and yet it ought not to require an expensive and cumbersome excrescence like a tail rod, to solve the problem with equal satisfaction. I am well aware that "traps" in a piston or anywhere, except to play with, are very objectionable, but I do not believe that one moving piece, and a few extra holes, can possibly be a detriment to a piston, while its cost, convenience, appearance and maintenance are not to be compared to a tail rod. In regard to efficiency, I can only say that I have not had a piston like that in Fig. 6 in use long enough to determine that point.

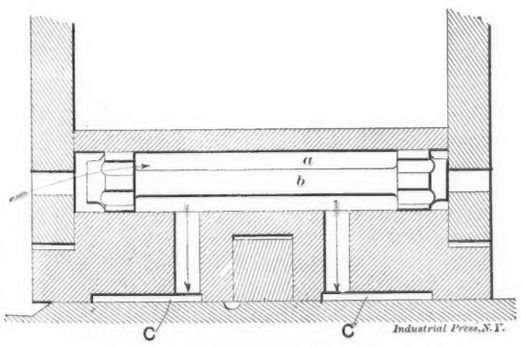


Fig. 6. Special Type of Piston.

A. L. Ide & Sons, Springfield, Ill., build two horizontal engines from 5 to 24 inches in diameter, and use a single piece piston and snap rings. I quote from their catalogue, page 59:

"The piston is a single hollow casting, very light, and so braced as to have ample strength. The packing rings are two in number, of cast iron, turned larger than the cylinder and sprung into place in the manner of a snap ring. The ends of the rings have lap joints which remain steam-tight, however much the rings may spring out from wear. The simplicity and reliability of this type of piston and packing are such that its adoption by engine builders has been universal." This last remark will cause the builders of Corliss, or the original Dunbar pistons, to wonder "where they are at," and those fellows who have had large experience in using packing rings will smile audibly when they read that a snap ring won't leak when it is worn out.

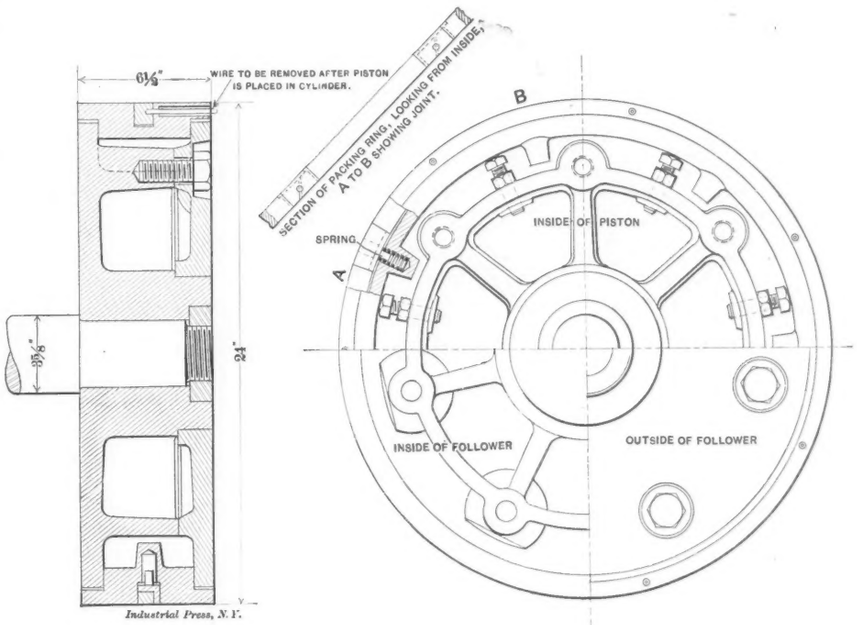


Fig. 5. Piston of the Wm. A. Harris Steam Engine Co.

The Reeves Engine Co., of Trenton, N. J., build horizontal and vertical engines, simple and compound, from 2½ to 32 inches in diameter, and say of their pistons at page 22 of their catalogue: "The pistons are of cast iron, thoroughly ribbed and braced, thus getting rigidity with a minimum of weight. They carry self-adjusting packing rings, and will run a long while without special attention." That statement seems to be "above suspicion."

* * *

Where high speed lathe tools show signs of brittleness, try reheating at the same heat as before, but instead of cooling in the air or in an air blast, bury the nose of the tool in ashes on the forge for a minute or so and then cool in the air.—*Sparks from the Anvil.*

* * *

To file a circumferential groove in a round bar so that it will be a fair approximation to one turned in the lathe, is not an easy matter for the skilled vise hand. A correspondent to the *Mechanical World* shows a little kink for doing such a job that should be useful to know. He secured a block of wood in the vise, which has a V-groove cut lengthwise in the top. The groove is cut in the wood to such a depth that the bar lies well below the surface of the wooden block. Another groove is cut across the block at right angles to the first. This is to guide the file. The iron bar having been laid in the first groove, the file is passed across it using the second groove as a guide. The bar is supposed to turn, but slower than the velocity of the file so that the latter cuts a groove of even depth all around and at all points in the same plane.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

Well preserved iron girders and beams are exhibited by the floor framing of a building, now being demolished, at the corner of William street and Exchange place, New York city. This building dates back of the Civil War. It has brick walls faced with marble, and floors of earth filling on an all-iron framing. It is noteworthy that the beams and girders show only spots of rust, the general surfaces showing either the original paint or, where the paint has scaled off, the oxide scale of the rolling mill. What say the corrosion howlers to this?—they who predict rapid deterioration of our steel structures, through rusting away.

Joseph L. Ferrell, of Philadelphia, has been awarded the Elliot Cresson gold medal by the Franklin Institute for his wood fire-proofing processes. These refer to means for impregnating raw lumber, the treatment of wood structures superficially and the fluid used for saturating, the base of which is sulphate of aluminum. By the ordinary impregnating process from 24 to 36 hours are required to saturate white pine boards; by the Ferrell process 15 minutes is said to be sufficient. When applied to the interior of finished buildings it does not interfere in any way with the use of varnish, etc., but has the remarkable effect of preventing "varnish flash" and making the surfaces fireproof.

It is reported that when water was turned into the great Sault Ste. Marie power canal, which has cost several millions of dollars, it was discovered that the piles supporting the large power house are underlaid with quicksand. In order to save the structure from undermining it was necessary to shut the water off and discontinue the informal test that was about to be made. The indications are that very extensive work will have to be done in strengthening the foundations, and it may be that the power house will have to be rebuilt. If true, some one has blundered seriously, as borings should have been made to considerable depths to ascertain the nature of the sub-strata before erecting thereon an expensive and important hydraulic power house like the one in question.

At the close of the annual commencement lecture at the Worcester Polytechnic Institute, there was an interesting experiment illustrating the trend of electrical engineering. The 500,000-volt transformer of the school, located in the high-potential laboratory, about 1,000 feet distant from the lecture room, was supplied with current taken through instruments on the lecture-room switchboard. This transformer was adjusted by the lecturer so as to deliver a potential of 120,000 volts, at a frequency of 60 cycles per second to a line of iron wire leading to the lecture room, where, on wires which were so small as to be invisible to most of the audience except when the room was darkened, the current was conveyed to another transformer of the electrical-engineering department, which stood beside the lecturer. This second transformer served to reduce the pressure to a value which could be applied to the primary of a rotary converter of about 10-horse power capacity located on the lecture table. This rotary converter was synchronized and operated from the line and ran with a load of incandescent lamps on the direct-current secondary. The experiment was especially interesting, as it was probably the first time that power has actually been transmitted at so high a pressure as 120,000 volts.—*Western Electrician.*

Machinery has been built by the Bethlehem Steel Co. for the manufacture of the Schoen solid forged and rolled steel car-wheel, which is of a very massive and interesting nature. In making carwheels by this process a circular steel ingot about 24 inches diameter is cast for each wheel, which is of a quality that has proven, in steel tires, to be the best for the peculiar service to which a carwheel is put. The ingot is forged under a hydraulic press of special design which forms the hub, reduces the thickness of the web and increases the diameter to about 28 inches. The hot blank then goes to a special rolling mill where it is embraced by six rolls, two on the tread and four under the rim and against the web. Here the blank is rolled to the standard diameter of 33 inches. From the rolling mill the wheel goes to double-acting hydraulic press where it is coned and dished so as to bring the edge of the rim in proper alignment with the hub. This press is capable of exerting a pressure of 5,000 tons. The rolling mill occupies a floor space 22 feet wide by 40 feet long and requires a 1,000 horse power reversible engine to drive the rolls. Three electric motors are provided to drive the feed of the rolls. These may be worked independently or simultaneously by the operator. When the proper thickness of the wheel is reached the feed automatically throws out.

One of the interesting phases of the use of the steam turbine is utilizing the exhaust of reciprocating steam engines at about atmospheric pressure and in turn exhausting into a vacuum. There are many classes of work in which the steam turbine can never be expected to successfully displace the reciprocating steam engine because slow rotative speed and positive instantaneous control in either direction are of more importance than the mere matter of economy or simplicity. This is the case notably with hoisting engines used in mines. But if the exhaust steam from such engines can be profitably used for driving machinery requiring steady motion, well and good. For this purpose the steam accumulator was designed by Prof. Rateau some years ago, by which the exhaust from intermittently operating engines can be stored and effectively used in steam turbines exhausting into a vacuum. A notable installation of the Rateau accumulators is that at the Bruay mines in France. The accumulator consists essentially of a large vertical cylinder built of boiler steel in which are placed heavy shallow cast-iron trays separated by narrow spaces through which the exhaust steam from the reciprocating engine must pass. The accumulator acts both as a condenser and as an evaporator. The exhaust steam at slightly more than atmospheric pressure condenses and collects in the form of water when the supply from the hoisting engine exceeds the demand of the turbine. Then, as the engine stops, the water re-evaporates as the pressure falls and keeps up a continuous supply to the turbine.

The plans for the third suspension bridge to be built across the East River at New York, and to be known as the Manhattan Bridge, have been the subject of much criticism, owing to the projected use of eye-bar cables instead of wire cables, as in nearly all suspension bridges. A committee of engineers, however, have rendered a report entirely favorable to the plans as drawn. They state that eye-bar chains were used successfully long before wire cables were in use and that the chains have decided advantages in the accessibility of all parts for inspection and protection, as well as in economy and rapidity of erection; they are to be preferred to wire cables whenever the cost of the chains is not materially greater. The cost of eye-bar chains and wire cables in this bridge would be about the same.

The Manhattan bridge will be a suspension bridge, having a central span 1,475 feet long between centers of towers, and two side spans of equal length, each 725 feet long, measured from center of tower to anchorage connection. Both central and side spans are somewhat shorter than the corresponding spans of the old East River bridge. The general design consists of four cables supported by steel towers or bents, each cable being a steel eye-bar chain, hanging in a vertical plane. The two center cables are 40 feet between centers and the side cables 28 feet between centers, making the total width 96 feet between centers of outside cables. Each tower or bent consists of four vertical posts, one under each cable, these posts having pin bearings at the bottom, the pins being carried on metal shoes of sufficient size to distribute the weights properly over the masonry.

One of the most important works accomplished by the National Bureau of Standards at Washington has been the standardization of thermometers as manufactured by different concerns in this country. Some time ago sample thermometers were asked of the various manufacturers by the Bureau and it was found upon investigation that they varied in some instances by as much as three degrees—a very critical amount in the temperature of a fever patient. The manufacturers have now all consented to adopt the government standard and if their thermometers are carefully made they will all register alike.

This is one of the things that the Bureau of Standards has done since it was established. Another important work is testing delicate weighing machines used in chemistry, pharmacy and the sciences. It is desired to get manufacturers of measuring and weighing machines to work from precisely the same standard of weights or measures so that all such apparatus will give uniform results.

Another practical work that the Bureau is carrying on is in getting makers of machinists' tools to work from one standard of measurement so that all such tools will be exactly uniform. We imagine, however, that no marked variations in standards will be found here, for machinists' tools run very uniform as a general thing.

Before long the bureau will be established in a specially-constructed building on a hill near Washington, where the delicate instruments will be removed from the influence of noise and electric currents. In this new building there will be rooms where the temperature will be kept exactly the same the year around, and there the work will be carried on to greater advantage than is now possible.

A. A. Knudson, at the annual meeting of the American Electro-Chemical Society, stated: During an examination in a city for electrolysis of water pipe our attention was called by the Superintendent of water works to several water meters which he believed had been ruined by electrolysis caused by railway currents. After making careful tests at locations where these meters had been in use, and not finding any signs of railway current, we had one of them taken apart for closer inspection. We found in the interior a brass valve arranged to move over iron slides, the slides being a part of the iron frame of the meter. Suspecting galvanic action, we made an effort to measure the voltage, and selecting a meter that was not so damaged as to entirely prevent its working, we connected the brass valve with an insulated wire leading it out through the discharge, thence to the millivoltmeter. Another wire from the iron casing was connected to the opposite pole of the instrument. We then turned on the water from a service tap and allowed the meter to work the same as in practice; the effect was instantly shown upon the millivoltmeter which registered from 0.004 to 0.008 volt; variations of the needle between the minimum and maximum were caused by the variations of contact between the brass valve and the iron guides, over the uneven surface; the water was slightly brackish. The iron case was positive to the brass valve; the interior iron parts were softened and broke away. The number of this meter was taken, and the records in the office of the Water Department examined to see how long it had been in use, which was found to be about twelve years; from this data we make the following deduction: A water meter or other like instrument constructed with dissimilar metals such as brass valves running upon iron guides in brackish water with an average difference of potential of 0.006 volt, will in twelve years be ruined by electrolysis due to galvanic action, and register inaccurately in a much shorter period. It is but proper to say that water meters of this construction have long since been changed by the manufacturer, and those now made by the same firm are differently constructed and are not liable to galvanic action in their working parts. Other instances of the use of dissimilar metals in various other constructions could be mentioned, such as in steam plants, but we assume that sufficient has been said to at least call attention to the evils which may result from the use of dissimilar metals in contact with liquids wherever they may be placed.

RE-ENFORCING PADS FOR BLOW-OFF PIPES.

A writer in the *Locomotive* calls attention to the right and wrong ways of attaching re-enforcing pads to steam boilers for the blow-off pipe connection. These pads are usually made somewhat thicker than the shell plates, and are riveted to the boiler to strengthen the portion weakened by the hole cut for the pipe. But there is no good reason for not using the metal of the shell to hold the pipe, since tapping through both nearly doubles the length of thread. Therefore the

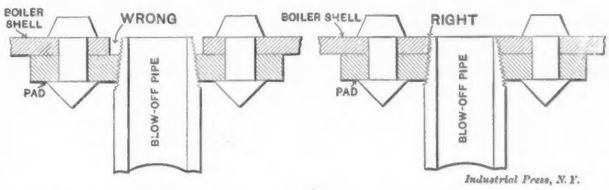


Fig. 1. Fig. 2.

method shown in Fig. 1 of attaching the pad, or rather of cutting the hole, is wrong. The hole in the boiler shell is cut so much larger than the outside pipe thread diameter that it can do no good toward holding the pipe in place. The right way to apply a blow-off pipe re-enforcing pad is shown in Fig. 2. The hole in the shell is made such a diameter that a full thread can be tapped. Both the thread in the shell and in the pad are, of course, tapped at one operation.

TREATMENT OF LEAKS IN CONCRETE WITH OIL.

Insurance Engineering, June, 1903, p. 539.

From the report of the Chief of Engineers, U. S. Army, 1902, it is learned that in the fortification work at Fort Caswell, North Carolina, it was found almost impossible, with the unstable subsoil, to prevent unequal settlement and consequent cracking of concrete. It was noticed that water falling on the concrete surfaces near the guns, which had been coated with the oil used on the guns, was not absorbed, and this led to a coating of the entire concrete mass with boiled linseed oil. Where large breaks occur, they are filled with cement grout, and the linseed oil is poured in as long as it is absorbed. There is formed in the crevice a gum from the oil which in time fills it to the top, after which the entire surface is coated with successive applications of the oil until it ceases to be absorbed. Previous to the trial of this method the two 12-inch emplacements were noticeably leaky, and for the purpose of experiment the worst of the two was selected and treated as above outlined, with the result that it was made perfectly water-tight. Since then all of the emplacements of the post have been treated in a similar manner, and may now be considered water-tight. It is thought probable that it will be necessary to give a coating of oil, at least near the openings, when the concrete expands and contracts in the spring and autumn, but this will be comparatively inexpensive and take very little time.

APPARATUS FOR WASHING MOVING TRAINS.

Railway and Locomotive Engineering, July, 1903.

A novel train washing apparatus is in operation on the Great Western Railway at the West London yards. It consists of a small shed built over a single track and through this a yard engine draws a train at the rate of about four miles an hour, and it comes out of the shed as clean as a good rub-down and cold water can make it.

On each side of the shed on a movable frame there are arranged brushes which are made to revolve rapidly and beside these brushes there are perforated water pipes which when the apparatus is in action, give a copious discharge of water. The whole is operated by steam power, and the men employed in the washing of cars stand behind glass screens which keep them from getting wet. By the manipulation of levers, the revolving brushes are brought against the sides of the coaches. There are water pipes on each side of the brushes, so that if by any chance the brushes should leave streaky patches the Niagara flow washes it off.

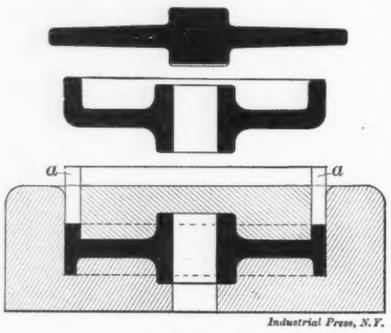
The brushes are on shafts driven by chain gear and sprocket wheels, so that water has no effect upon them, and the track is arranged to drain the water off as rapidly as it falls. Some-

thing less than a thousand coaches are thus given their "tub" every day with thorough English regularity, and the railway company has found the washing shed to be a time and labor saver. The plant is the property of the Universal Carriage Washing Syndicate of London.

DISK AND SPOKE WHEELS.

Zeitschrift fur Werkzeng Machinen und Werkzenge, April 15, 1903, p. 297.

By means of a new process brought out by Ernst Römer at Gleiwitz, wheels and pulleys, applicable to a great variety of purposes can be formed out of steel castings. The raw material required consists of a blank either with a full or hollow hub as shown in Fig. 1, and formed into the rough shape either by hammering or casting. These blanks are then heated and



Figs. 1, 2 and 3.

brought into the shape indicated by Fig. 2, between dies worked either under a hammer or a powerful press, by which the rim will be turned back and made symmetrical on each side of the disk or spokes. This latter formation is effected either at the same or a subsequent heat by means of the hollow stamp, *a*, Fig. 3, whereby a uniformity and proper distribution of the thickness of the metal is brought about. G. L. F.

HOISTING FROM GREAT DEPTHS.

Engineering and Mining Journal.

In the course of a review of a paper read by H. C. Behr on "Winding Plants for Great Depths" Robert Peele says that the variation of load moment on a hoisting engine due to the varying weight of the rope, is enormous. The best steel is used for the ropes of deep shafts, being plow steel having a tensile strength of from 200,000 to 250,000 pounds per square inch. But even with the high average tensile strength of 250,000 pounds a rope 1.52 inches diameter is necessary for hoisting a net load of 8,000 pounds in a skip weighing 5,000 pounds from a depth of 6,000 feet. A wire rope of this size and length, weighs 22,500 pounds, and with the skip and contents weighing 13,000 pounds, the load varies from 35,500 pounds at the bottom to 13,000 pounds when the skip is at the top of the shaft. To compensate for this variation of load conical winding drums are employed, but there are practical difficulties in using perfectly compensated conical drums for very deep shafts. From the principle of the conical drum it is obvious that while the difference between the end diameters of the drum increases with the depth of the shaft (or the length and weight of the rope), the axial length of the cone does not increase proportionately to the diameter of the larger end. In other words, if the end moments be made equal, the angle which the element of the cone makes with its axis becomes excessive for a very deep shaft, which may lead to difficulty in properly fleeting the rope upon the drum, and even to a liability that the rope may slip from a groove, thus causing a dangerous shock or even breakage. For depths of less than 3,000 or 3,500 feet this difficulty is not serious, but for depths approximating 5,000 feet the angle of the drum becomes extremely steep, provided it is really designed to attain equalization. A case in point is the huge double conical drum of No. 3 shaft of the Tamarack Mine, which is 10 feet diameter at the small end and 36 feet at the large end, the angle of the cone being about 52 degrees. This drum is designed to hold 5,500 feet of rope on each side, the portion from 17 feet to 36 feet diameter being used for hoisting from 4,500 feet. Trouble has been experienced with the fleeting of the rope on this drum, and the maximum speed of hoisting is kept lower than at shaft No. 2, which is provided with a cylindrical drum 30 feet 6 inches in diameter. In Tamarack shafts Nos. 1 and 5, combination conical and cylindrical drums are employed. For a double compartment shaft the larger part of the drum is cylindrical, terminating at each end in a short frustrum of a cone. Each rope in turn winds up the conical surface and then over the cylindrical part, the latter being alternately occupied by the over and under ropes.

THE AUTOMOBILE AND THE RAILWAY AS TRANSPORT AGENTS.

Engineering Magazine, July, 1903, p. 481.

The author denies that the automobile can ever become a serious competitor to transport lines having steel rails to carry the load. While the automobile is undoubtedly destined for a much broader field of activity than it now enjoys, it must always remain a vehicle of pleasure and a means of freight transport for limited distances only. This applies to streets and roads covered with ordinary paving or macadam. The traction or pull of a vehicle on the best macadam road is at least four times that on steel rails; on some macadam roads it is eight times as great. The steel road is as much better than macadam as macadam is better than mud. A locomotive which cannot propel itself more than twenty-five miles an hour on the best macadam road, can pull a long train of cars at that speed on steel rails. Running cars on steel rails has changed the world more than any invention ever made, extending commerce, spreading civilization, promoting peace, unifying nations. That it is the steel rail more than the locomotive that has worked these great changes is shown by the fact that the locomotive at work off of steel rails has accomplished very little, although it has been in actual or attempted use longer than the locomotive on rails. Railways without locomotives, such as horse-railways and cable-railways, are able to carry passengers three or five times as far for a nickel as any vehicle on any other kind of road. In the first case the railway is maintained by the transportation company, and in the second case the road is maintained by the taxpayers and is entirely free to all users. The average cost of hauling freight by road locomotives is at least ten cents per ton mile; on the Pennsylvania Railroad it is only one-half cent. It is one of the great disadvantages of vehicles not on steel rails that they must be steered around each other, thus pursuing a serpentine course which adds to the distance and makes high speed dangerous. Sixty miles an hour is safe on rails; fifteen miles an hour is dangerous on macadam. Again, a dollar's worth of steel will probably outwear a dollar's worth of macadam. The life of a traction engine is only four or five years; that of a locomotive is fifteen to thirty years. The automobile instead of becoming a menace to the railway, will become a feeder to it. Its efficiency will be greatly increased by the laying of plate rails, but it then becomes a locomotive traveling on a railway. The steel plateway for city streets cannot become a great success for automobiles until they become so numerous that the horse is practically banished as a factor in hauling a city's freight.

THE CUTTING ACTION OF HIGH-SPEED STEEL.

Abstract from Paper read by W. H. Maw before the Institution of Civil Engineers, June 16, 1903.

A few years ago the claim of this subject, "The Action of Cutting Tools," to be regarded as an "unsolved problem in engineering" might, perhaps, have been disputed, but in view of recent developments the matter has assumed a different aspect. The matters which have had the most important influence in bringing about the present conditions are two—viz., first, the extensive adoption of automatic machine tools; and, second, the introduction some three years ago of the so-called "rapid tool steels," capable of working under conditions previously regarded as impracticable. The use of automatic machine tools has accelerated materially the adoption of the system of employing, in machines, tools which have been ground to certain definite forms and cutting angles, which

the man in charge of the machine is not allowed to modify. To secure satisfactory results under such a system it is evident that strictly definite knowledge is necessary of the form of tools required, as well as of the character of steel of which they are made and its treatment. What is required in such tools is not only good cutting action at high speeds, but also the power of maintaining the cut for considerable periods without requiring readjustments; and to enable these conditions to be fulfilled with the older classes of tool steel, very efficient lubrication or cooling of the cutting edge was essential. On the other hand, the new classes of "rapid tool steel," such as the Taylor-White steel and its successors, work well under quite different conditions; they can be run dry at exceptionally high speeds and under heavy pressures, and can, without injury, be allowed to attain temperatures which would at once ruin any ordinary steel. Now we are here brought face to face with an apparently utterly abnormal condition of things—a condition which is not only of high importance in itself, but of even greater importance as indicating how extremely limited is the knowledge which we possess of the materials available for our use. To what, then, is the action of these rapid steels due? This is a point which has as yet been far from fully investigated; but experiments have been made by Mr. J. Spüller, the chemist, and Messrs. Whilacek and Hatlanek, engineers, of the Poldihütte, Kladno, which, together with the researches of Mr. Fridolin Reiser, of Vienna, throw considerable light on the matter.

The new tool steels contain in addition to iron and carbon —chromium, tungsten, and sometimes titanium and molybdenum, and Mr. Spüller's view is that, in the point of the tool, the excessive heating causes a portion of the carbon to leave the iron and form high carbides of chromium and tungsten. These higher carbides exist in the form of needle-like crystals of intense hardness, which are embedded in the soft iron carbide as in a matrix, and which form the real cutting portions of the tool. This view is supported by the fact that the points of these tools harden in use, and also by the form assumed by the tool points after heavy service; but it cannot be said to be absolutely proved, and the assumption that the formation of the crystals of chromium and tungsten carbides is due to the heating alone does not seem to satisfactorily explain the difference which apparently exists between the point and the immediately adjacent portions of one of these tools. There is, however, another action going on which may, I think, exert an important influence, and that is the extremely intense pressure to which the point of such a tool must necessarily be subjected. Of course, this is merely a suggestion, but I think it not improbable that further research may show that intense pressure and heat in combination can produce an effect which would not result from heating alone.

THE EFFECT OF VACUUM ON THE STEAM TURBINE.

Power. July, 1903. p. 400.

The steam turbine is very sensitive to a vacuum. A couple of inches additional vacuum will increase the efficiency of a turbine much more than it would that of a reciprocating engine. It is easy to see why this should be so. In the reciprocating engine of the most refined type more than twenty expansions are rarely used, usually less. In the steam turbine one hundred expansions may be easily realized. Conceive of a steam diagram with twenty expansions. If the counter pressure could be lowered two pounds, an area would be added to the diagram equal to the product of the width representing that pressure and the length of the diagram. Suppose now the number of expansions be increased to one hundred. Since the length of the diagram represents the final volume, the diagram would be five times as long and the lowering of the counter pressure line two pounds would add five times as much area as it did in the former case. In addition to this area, another gain is derived from the further expansion.

With equal ratios of expansion, as where both engines exhaust against a pressure of, say, five pounds above the atmosphere and the reciprocating engine diagram ends in a point, the turbine will probably be less efficient than the reciprocating engine. The turbine owes its efficiency to the large ratios of expansion which it can utilize and even with these ratios is able to attain efficiencies only equal at best to those of the best piston engines. The reciprocating engine suffers some 20 per cent. from internal condensation, due to the alternate heating and cooling of its surfaces. The turbine suffers probably more from lack of mechanical efficiency. When steam is confined its pressure is positively exerted upon the containing surfaces and any increase of volume is positively productive of the corresponding amount of power. In the turbine the energy of the steam is first put into inducing motion in the jet or current and then the turbine is used to absorb it. This it can do perfectly only by bringing the steam to absolute rest, and in the absence of eddy currents and friction. The best water turbines convert only about 80 per cent. of the energy of the water, and probably the steam turbine is no more efficient as a turbine, so that whatever advantage the turbine may have over the reciprocating engine in the avoidance of internal condensation is probably offset by its lack of efficiency as a motor.

Another reason why the vacuum is of particular value to a turbine is the reduction which it effects in the windage. A top will spin for an enormously long time in a vacuum. If it had to spin in an atmosphere of compressed air or high-pressure steam, its motion would last for a comparatively shorter time. At the high speed at which the turbine vanes are run the frictional resistance in the dense high pressure steam of the earlier stages must be considerable, but in the much less dense atmosphere of the later stages much less of the energy absorbed is used in overcoming friction. Of course energy cannot be continuously imparted to steam in a confined space without heating it, so that the heat developed by this and other forms of fluid friction may go to improving the quality of the steam and preventing its condensation.

Since the turbine is less efficient than the reciprocating engine in the early stages of expansion, but is capable of carrying the expansion practically to so much greater an extent, the idea suggests itself that the turbine might be used to replace the low-pressure cylinder of a compound engine. This would mitigate the loss from internal condensation, as all the heat which goes into the first cylinder, with the exception of that lost by radiation and converted into work, must pass to the receiver and would be available for use in the turbine through the lower temperature range. Great ratios of expansion would be available and the enormous cylinders necessary for even the limited ratios now attained would be avoided. The simplicity and compactness which are such attractive features of the turbine would be, however, in a measure sacrificed, as would the particularly advantageous use of superheated steam and the avoidance of oil in the condensed exhaust.

THE HEISLER COMPENSATING GEAR FOR DIRECT-ACTING PUMPING ENGINES.

Engineering News, June 4, 1903, p. 497.

Chief among the defects of direct-acting pumping engines are the variable length of stroke, inability to run at high speeds, and unsatisfactory steam distribution, leading to poor economy. Crank-connected pumping engines overcome these defects, but only at the expense of lightness and low cost. In direct-acting pumps the resisting force in the water cylinder is constant throughout the stroke and is equal to the delivery head of the pump; the steam pressure must, therefore (neglecting the inertia effects of the moving parts), also be constant. In other words, full steam pressure must be used throughout the stroke. The advantage of steam expansion is therefore lost and the pump is very wasteful of steam.

The inertia of the moving parts tends to correct this evil. They absorb energy during the first part of the stroke in the acceleration of the mass of the pistons, rods, etc., while the last part of the stroke these masses being brought to rest give up this stored energy. Therefore, instead of a constant steam pressure being required throughout the stroke it is necessary that the pressure during the first half of the stroke be higher than the average, and lower than the average during the latter part of the stroke. If the reciprocating parts be made very massive this effect may become large enough to permit of quite early cut-off. This method has rarely been employed, however, because of its expense, although in the

D'Auria pump a column of water, contained in a closed circuit of pipe, is substituted for the heavy metal reciprocating parts. Another method originating with Mr. A. S. Cameron has been used in modified form in the Worthington high-duty pumping engine, in which there are auxiliary hydraulic cylinders attached to the piston rod in such a manner that they force water into an accumulator during the first part of the stroke and during the second half of the stroke the plungers in these cylinders are driven by the pressure water stored in the accumulator.

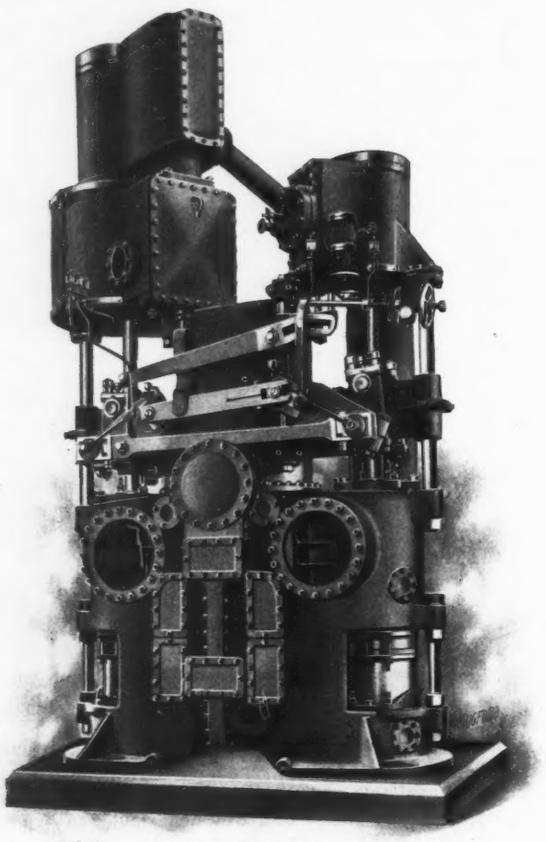


Fig. 1. Triple-expansion, Direct-acting Heisler Pumping Engine, with Compensating Mechanism.

A few years ago Mr. Charles L. Heisler devised a direct-acting pump in which compensation is secured by novel means, different from any of the foregoing. His construction comprises essentially a link connection between the two piston rods of a duplex or compound pump. By means of this linkage the steam cylinder of one side during the first part of the stroke gives aid to the other side, which is then in the last part of its stroke, and in turn when near the end of its stroke it receives aid from the other side. The linkage also gives each of the two pistons a definite, fixed length of stroke in place of the undetermined and variable stroke of the ordinary pump. As a result clearance spaces may be made small and a smooth action is obtained at all speeds.

In Fig. 1 is a general view of a large size Heisler engine which illustrates the general arrangement of the mechanism. It has a triple-expansion steam end direct-connected with two water cylinders. The intermediate and low-pressure cylinders are set tandem, together with one of the water cylinders, while the high-pressure cylinder is set in line with the other water cylinder. The engine has a capacity of 10,000,000 gallons per day. The steam cylinders are 21, 33 and 48 inches by 24 inches stroke, and the pump plungers are 19 inches diameter.

The "compensating" linkage is seen in Fig. 1 between the steam and water ends, and consists of two functionally separate parts: The compensating linkage and the valve gear. Since the former is the essential novelty of the pump it will be explained first by the aid of Fig. 2.

The device consists of two crank arms, C and C', pivoted to the frame casting of the engine, and having their free ends connected with the piston rods by links L and L'; the free ends are also interconnected by a rod, F, which has no fixed attachment to the frame and is called the floating rod. The piston rods of the two sides of the engine being thus linked together, they have definite relative motions, and any deficiency in moving force on the one side will be made up by aid from the other side. The relative positions of the two sides at four different points of the stroke are shown in Fig. 2. At A the low-pressure side has just completed its up-stroke, and the high-pressure side has traveled about one-third of its stroke from the bottom; the former has an excess of moving force during the first part of its stroke and aids the high-pressure side during the remaining two-thirds of its stroke. At B, the high-pressure piston has completed its up-stroke under continuous aid from the other side, and during the first third of its down-stroke its excess of moving force aids the low-pressure side in completing its stroke. It will be observed that the floating rod F is in tension throughout the conditions A and B. At C and D are shown the respective positions one stroke later than A and B; evidently the action is the same as that described; the low-pressure side during two-thirds of its up-stroke aids the other side, and the latter aids the low-pressure only during one-third the stroke.

As shown in Fig. 2, the low-pressure side leads the high-pressure by about two-thirds of a stroke. With this arrangement it is clear from the preceding description that the high-pressure side receives more aid than it returns; it has the benefit of the high initial moving force on the low-pressure side during two-thirds of its stroke, while it in turn aids the low-pressure only during one-third its travel. This makes it possible to employ a very early cut-off in the high-pressure cylinder and thus secure economy in steam consumption. If the direction of motion were reversed, the above relation would also be reversed, and in this case the low-pressure side would receive more aid than it gives.

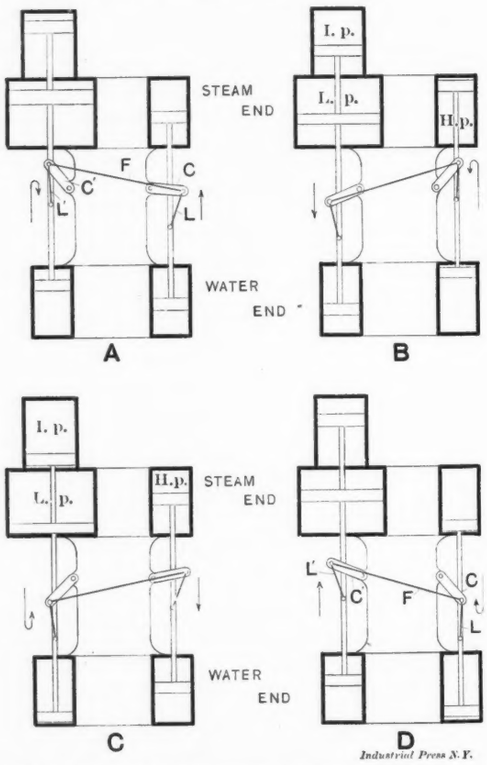


Fig. 2. Diagram of Compensating Linkage and Valve Gear.

In connection with this compensating linkage Mr. Heisler usually employs a peculiar valve gear, which takes its motion from the links of the compensating motion. The purpose of the gear is to secure rapid opening and closing of the valves by an action which shall operate smoothly at all speeds. In Fig. 3 is shown a compound pump, the high-pressure cylinder being on the right, fitted with compensating links. The tail of each crank arm of this linkage is extended to give an attach-

ment for the valve-gear links. From this point of the low-pressure crank arm a lever, *G*, extends over to the high-pressure crank arm, in whose tail is fastened a pin on which lever *G* slides. This pin can be moved toward or from the crank arm center for the purpose of adjusting the point of cut-off in the low-pressure cylinder. At *L L*, on the lever *G*, the low-pressure valve stem is fastened by means of a link. The high-pressure valve is connected in a similar way to a lever, *H*, which at one end is linked to point *H L* on the tail of the high-pressure crank arm. The other end of lever *H* is attached somewhat differently from lever *G*, being connected by means of a link to a point on the floating rod of the compensating linkage.

The motion of either valve is determined in the main by the motion of its piston rod, valve and piston rod moving approxi-

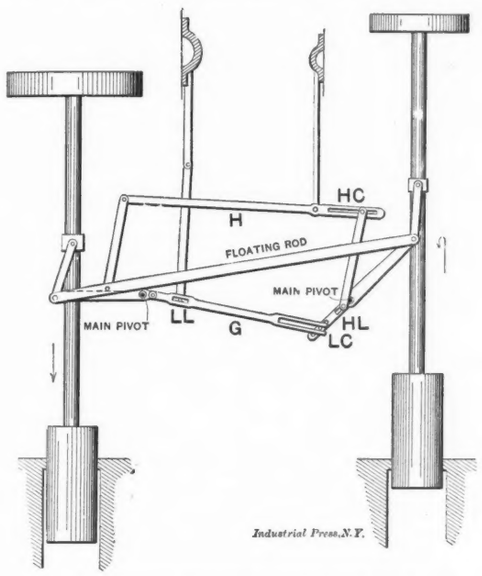


Fig. 3. Diagrams showing Operation of Valve Gear.

mately in opposition; but when the corresponding piston is near the end of its stroke, and is consequently moving slowly, the influence of the other piston becomes the dominating one, and it acts upon the gear so as to give the valve a rapid motion in this part of its travel.

At the points marked *L L*, *L C*, *H L* and *H C*, the pins connecting the separate levers of the valve gear are adjustable, as indicated by the slotted holes, for the purpose of adjusting the amount of lead and the point of cut-off in the two cylinders.

DRAWING OFFICE EQUIPMENT—UNIVERSAL DRAFTING MACHINE.

Paper read by John B. McGeorge at Saratoga Meeting of the A. S. M. E., 1903.

One of the interesting and valuable papers presented at the Saratoga meeting of the American Society of Mechanical Engineers (June, 1903), was that by John B. McGeorge on drawing office equipment. Mr. McGeorge made a strong plea for better drawing office equipment and facilities than are usually provided. He said there are many prominent engineers who look upon drafting as merely a means to an end, and the end they seek is so much more important in their opinion than the means, that the drafting is too trivial to be given their attention. For the sake of comparison suppose a rolling mill is to be designed. Much attention is paid to the design, but the mill is merely a means to an end. Suppose that rails are produced by this mill—they are simply a means to another end—and so on indefinitely. It is estimated that from $45,000,000 to $50,000,000 is paid to draftsmen in this country in one year. In view of this enormous expenditure it would seem that the drawing office should receive more attention than it does and its equipment be such that it not only can produce drawings in the cheapest way possible, but also in the best way possible. To illustrate the "penny-wise-and-pound-foolish" methods of economy sometimes practiced, mention was made of the experience of a chief engineer who took charge of a large force of draftsmen. He found that the man who had been in charge was buying the cheapest kind of paper and the cheapest supplies that could be obtained. By this parsimonious practice he succeeded in cutting down the supply bill from $60 a month to $30 a month, making a net saving of $360 a year. But the salary item was $100,000 a year and to save $360 he was jeopardizing the $100,000 item, and probably losing from $10,000 to $15,000 a year.

Then again some engineers will state that they have draftsmen who can accomplish more with a short stub of a pencil, a cheap tee-square, and some old rusty instruments, than other men can do with the very finest equipment. This is very true, but it does not follow by any means that the first man would not accomplish more with a better equipment. There is still a great necessity to insist upon the truism that the best men in the best surroundings, and with the best conveniences, do the best work.

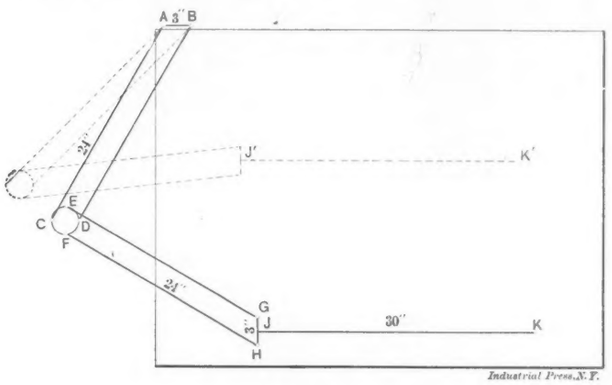


Fig. 1.

"Our stenographers are supplied with good typewriters and nice desks, and our clerks with the best equipment that can be provided for them. In the shops we are anxious to put in all the labor-saving machinery possible, but in the drafting room, where salaries are very much higher and where any saving counts a great deal more, both directly and indirectly, it is very generally true that the equipment is often cut down to a deplorable extent. It certainly ought not to be so.

The first point to be considered in the equipment of an office is the question of light. Daylight is the best as well as the cheapest, but is not at all times obtainable. In large drafting rooms this light is not usually sufficiently diffused. The windows should be as high and as near the ceiling as possible, so that the interior of the room may receive light. The man next to the window should only have control of the shades covering the lower half of the sash, and the shades, both upper and lower, should be translucent. There are only two methods of artificial lighting which have proved to be

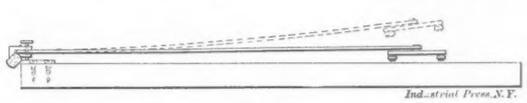


Fig. 2.

perfectly satisfactory. The one is where arc or Nernst lights are used and the light reflected from them against dead white ceilings and walls. This gives good general illumination, which, if properly done, will dispense with individual lights. The other method, which has given satisfaction, is the individual adjustable electric lamp for each board.

Another important consideration is that of ventilation. No draftsman can do his best work without an abundant supply of fresh air. This is a matter that is receiving more and more attention in the designing of schools and public buildings, and it is beginning to receive considerable attention in offices. A very practical question arises as to the number of square feet area to be given to each man. There are three factors entering into this question. First, the convenience of the draftsman, allowing ample room for reference drawings,

etc.; second, ventilation; and third, sufficient room so that those supervising the work can get around the office without disturbing the men in passing. It is believed to be good policy to allow at least 100 square feet for each man. The American Bridge Co., employing hundreds of men, allows considerably more than this. In regard to the sanitary arrangements, the toilet room should be immediately off the drafting room instead of being in some inaccessible nook as is too often the case.

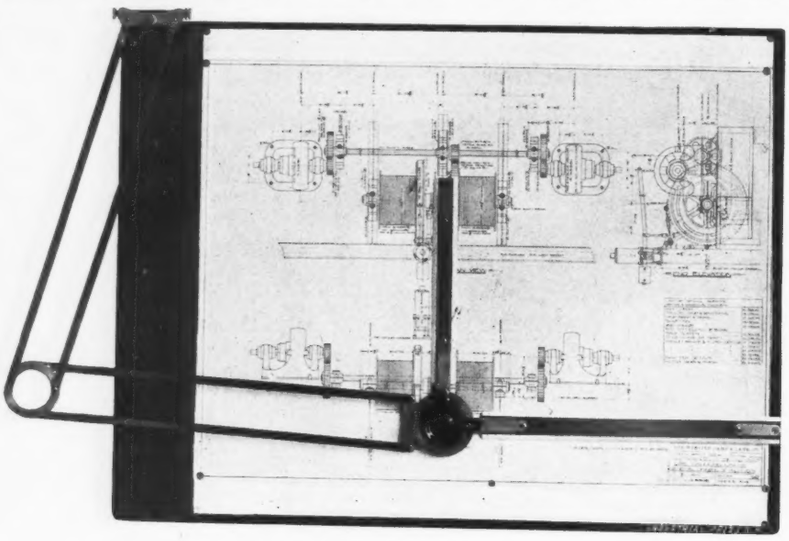


Fig. 3. Universal Drafting Machine.

The employers of the author, the Wellman-Seaver-Morgan Co., have been using a large number of Svenson boards, which have a frame carrying a parallel ruler on the Bergner principle, and in which frame can be placed a loose board, thus enabling a number of different drawings to be worked on without disturbing the paper on the board. The Svenson board can be placed at 60 degrees, 45 degrees, or flat (the ruler being balanced), and this to anyone troubled with bilious headaches is a great blessing. But several objections were found to the use of the vertical drawing boards for average size drawings, so later a table was designed which could be adjusted in height and slope and used in connection with the T-square or the "Universal" drafting machine. The objections referred to, are mainly three. Some of the men objected to holding their arms up about even with their shoulders all day long, and then again the vertical board does not give them opportunity to have their reference drawings and other data scattered conveniently around as does the horizontal board. The third objection is that of the superintendent who does not like to have the office divided off into stalls.

The "Universal" drafting machine referred to is the invention of Charles H. Little, and was worked out by him while employed in the drawing office of the Wellman-Seaver-Morgan Co., where it first received practical trial. Fig. 1 shows the principle of the device in outline. It consists essentially of the two arms, AC and BD pivoted at one end to the corner of the drawing board and to a ring at the other end. Midway on the ring between the latter pivotal points are connected the arms EG and FH, which are connected at the other end by a third member upon which is mounted the straightedge JK. When the straightedge is moved to another position on the board, it remains parallel to its former position as indicated by the dotted line J' K'. The arms then assume the positions indicated by the dotted lines. The device is, in fact, a parallel motion in which the member AB is fixed. But the length of AB is only 3 inches, while the length of the arms is 24 inches and that of the straightedge is 30 inches. The first impulse of almost every practical man would be to say that the thing is unpractical to manufacture simply because it would not be possible to make it in numbers, of sufficient accuracy to meet the requirements of the draftsman. The cross-bars AB, CD, EF and GH, are all three inches center to center of the pivots. Any looseness in the bearings would be multiplied ten times out at the end K of the 30-inch straightedge JK. But as the practical variation found is only about 1-100 inch it shows that there is a looseness of only about 1-8,000 inch in each of the eight bearings, which indicates a degree of accuracy in machines made in numbers that is surprising. Another feature of vital importance is that all the arms shall be of equal length, otherwise the

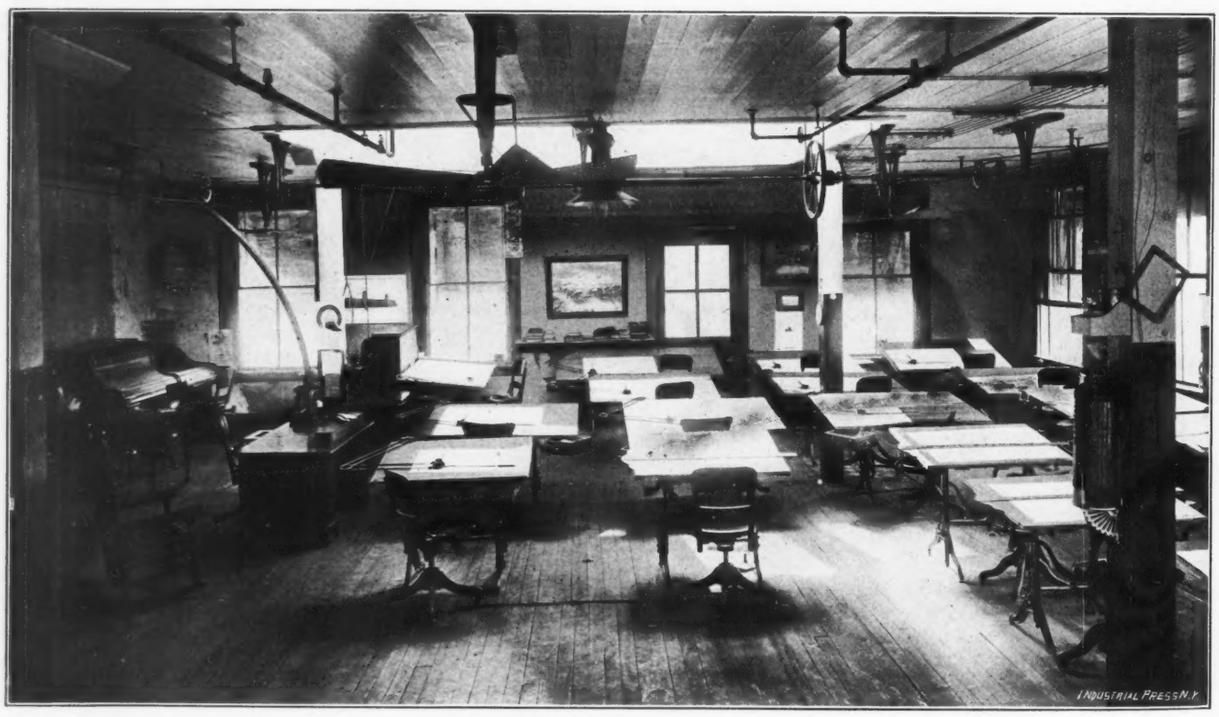


Fig. 4. Drawing Office of the Dodge Manufacturing Co.

position J' K' would not be parallel to that of JK. The arms should not only be of the same length, but they should also be straight and parallel with the board when in their working position, especially AC and BD. The first condition must be obtained by accurate "jigging," but the second condition is obtained by giving AC and BD an initial set upwards as indicated by the dotted lines in Fig. 2, which is a view of the device looking at the left end of the board. The weight of the ring and the other set of arms then brings these rods downward to a position parallel with the table. This is very important, as the sag of the arms in an instrument of so accurate construction, was found to be a most serious matter. The joints work on straight pins which are hardened and ground. A cone joint, adjustable for wear was first used, but this has been discarded as it was found difficult for the users to make the fine adjustments necessary for accuracy. They cannot tinker with the straight joint, and as soft, straight pins even have shown no perceptible wear after long use there is really no need for an adjustable joint, especially when the straight pins are hardened.

The photograph reproduced in Fig. 3, shows one of the machines mounted on a drawing board with two scales, also used as straightedges, mounted at right angles on the protractor head. The normal location of the stationary pivots is at the upper left-hand corner of the board. The drawing shown is that of an ore-handling crane drawn to the scale of 3-4″ = 1 foot. The horizontal straightedge is 18 inches long and the vertical one is 12 inches long. Both are reversible, clips being provided at both ends for engaging the connections mounted on the protractor head. The use of scales as straightedges is said not to be detrimental to them since the graphite of the pencils acts as a lubricant. The protractor is made with spring stops for the angles most commonly used; it may also be clamped at any required angle. With this feature it is obvious that angular work may be as readily done as ordinary work, *i.e.*, vertical and horizontal lines.

The drawing room illustrated in Fig. 4, is that of the Dodge Manufacturing Co., Mishawaka, Ind., which largely uses the "Universal" drafting machines, twelve being shown in the view. In other respects this drawing room conforms to the ideas set forth in Mr. McGeorge's paper. The lighting is unusually good, although perhaps as not as well diffused as it should be. Fans are provided for circulation of air in hot weather, and a pneumatic message tube connects it with all principal parts of the shop.

AN INDICATING ANGLEMETER.

Abstract from Paper read at the Saratoga Meeting of the A. S. M. E., June, 1903, by C. E. Sargent.

Ever since it has been desirable to operate alternating generators in parallel, the question of getting a prime mover the angular velocity variation of which shall come within the limits prescribed by the generator manufacturers, has been an important consideration. When Corliss engines were first used for incandescent direct-current lighting, many of them had such light-weight flywheels that an observer could count the revolutions of the engine by the variations in candle-power of the lamps. Generally speaking, the heavier the flywheel—other things being equal—the less will be the angular velocity variation during a rotation; but the heavier the flywheel the greater the first cost and the more power required to revolve it in its bearings; hence a flywheel just heavy enough to vary less than the maximum allowed is more economical than one of greater weight. In order to be able to determine at sight the actual maximum variation in steam-engine flywheels, and more expressly in the flywheels of internal combustion engines the instrument herewith described was designed.

If a light pulley is driven by the engine shaft with a flexible, inelastic belt, it should vary in speed commensurate with that of the engine. If a heavy flywheel at a high velocity is kept in motion by a tension spring having a practically uniform pull, there should be no change from a uniform velocity during a revolution of the engine. The device described indicates in circular measure the variation of the engine flywheel from a uniform velocity.

The anglemeter consists of a heavy main frame and base, and two uprights with bearings on each which carry the moving parts.

The shaft A, Fig. 1, to which the intermediate bevel pinion axis D and the segment F are rigidly attached, carries the flywheel and bevel gear B, the driving pulley C and the gear E; the latter are fastened together by the feather I. The rotation of the shaft A and the parts fixed to it, is limited by the stops K, Fig. 3. Motion of this shaft and segment F is transmitted to the pinion G and segment F' and the pinion G', which is loose on the pin M, and carries the needle O. The driving pulley C is made very light, with two diameters for high and low speed engines, and is fastened to gear E by the feather I and nut P.

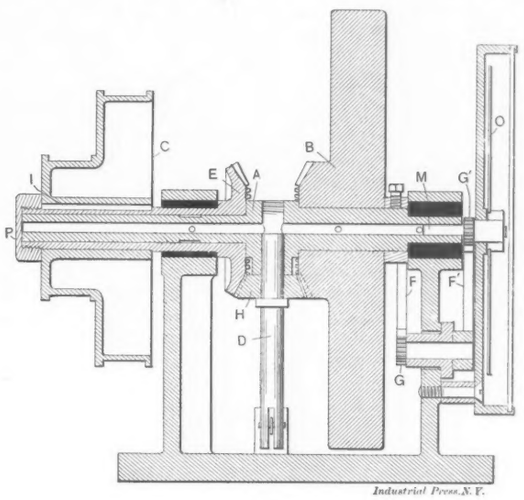


Fig. 1.

The axis D is held in a vertical position by the two opposed torsion springs, Figs. 3. By using two springs under tension a large movement for a small increment is obtained, and the anglemeter may be run in either direction; and when running, a proper adjustment of the tension nuts brings the needle to a vertical position on the dial. A hair spring around the pinion G', not shown in the cut, eliminates any lost motion in the multiplying gear. The anglemeter is driven by a belt from some part of the engine shaft, which through the intermediate bevel pinion and the tension springs, drives the flywheel in the opposite direction at a uniform velocity.

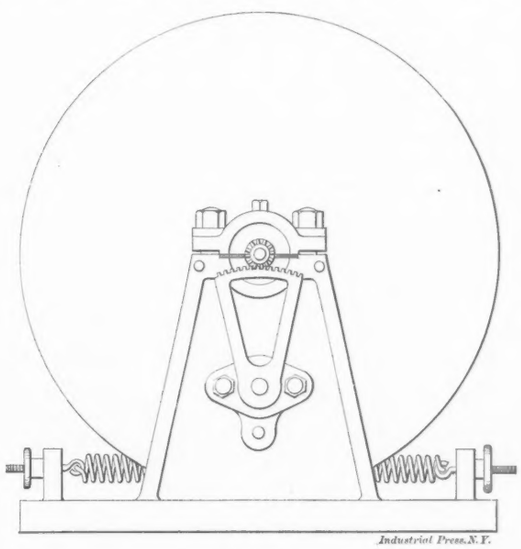


Fig. 2.

If the tension of the springs which tend to hold the intermediate bevel-pinion axis in a vertical position is equal to the pull necessary to keep the flywheel rotating at a constant speed, then a change in the angular velocity of the driv-

ing pulley which varies with the change of the engine speed allows the axis of the bevel pinion to vary one-half the angle of driving pulley.

If the diameter of the pulley on engine shaft is such that the velocity of the anglemeter is 7.2 times faster than the engine, its angular variation during one rotation of the engine will be 7.2 times greater, and the angular variation of the axis of intermediate bevel pinion from a vertical or normal position will be 3.6 times greater than that of the engine; and the needle, which has an angular movement 100 times greater than the bevel-pinion shaft, will therefore have 360 times the angular movement of the engine flywheel from a uniform rotation. Therefore if the engine flywheel should vary one degree during a rotation, the needle on the dial would vary 360 degrees, or make a complete half revolution each side of the normal position. As the dial has 360 divisions or degrees, one minute variation of the engine shaft would show six degrees on the dial, and ten seconds variation of the engine would show one degree on the dial.

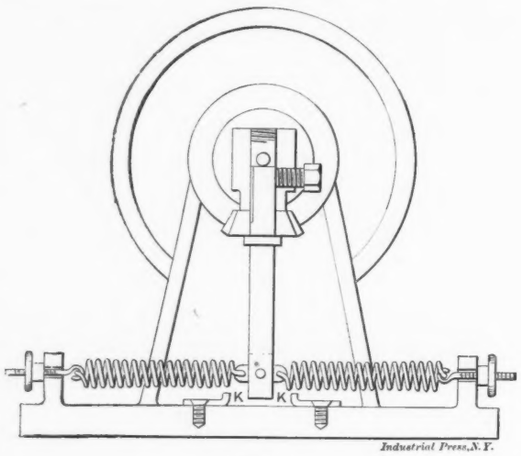


Fig. 3.

A belted tachometer from the anglemeter flywheel shows a uniform speed under extreme angular variations of engine flywheel, which might be expected, however, when we consider that for a variation of one degree of engine the change in the length of springs is less than ¼ of an inch, and that for a variation of one minute the length of springs varies less than .004 of an inch. If, however, an engine is racing, the speed of the anglemeter flywheel will rise and fall in proportion to that of the engine, for it makes in a minute some multiple of the engine speed.

The belt which is used to drive the anglemeter is a piece of special cotton tape one inch wide, butt-jointed with an ordinary over-cast stitch, which makes it practically endless; and as there is no perceptible stretch and but little inclination to creep, the speed of the light driving pulley of the anglemeter should vary exactly with the engine speed.

The amount of deflection of the needle each side of normal is readily seen when the anglemeter is in operation. When applied to a gas engine working under normal conditions, having two impulses per revolution, as good results are obtained as from a single-crank steam engine, but if abnormal conditions arise, such as premature or missed ignitions, the trouble is at once located by the needle's usual deflections.

THE HOT WELL AS AN OIL EXTRACTOR.

Paper read by A. H. Eldredge at the Saratoga Meeting of the A. S. M. E., June, 1903.

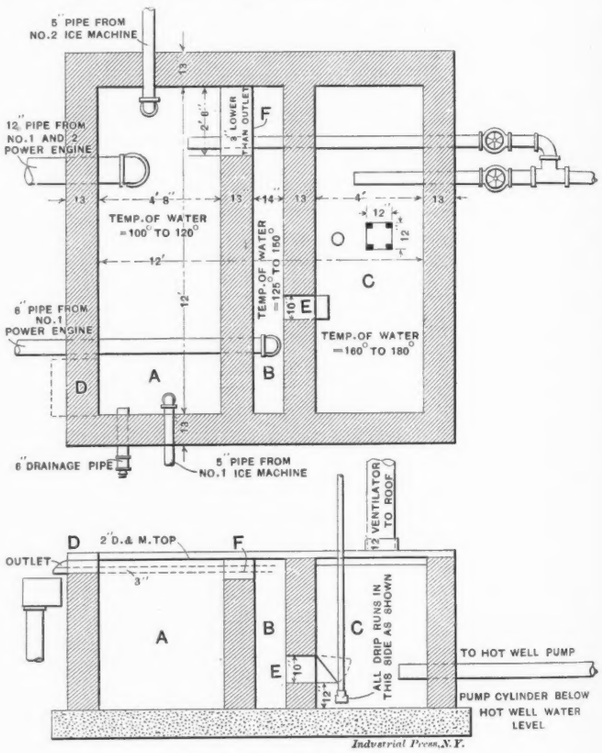
Figs 1 and 2 give the plan and cross-section of a hot-well that has been in successful operation during the past year. The well is divided into three parts:

A, the common discharge side for the steam condensers; *B*, the discharge side for one steam condenser; and *C*, the hot side, or pump side.

The operation of the well is as follows: The bulk of the condensing water enters at *A* and overflows, to a cistern, at *D*. The water from a single jet condenser enters *B*. The water from this condenser comes from an engine that runs continuously nearly the entire year. Its temperature is kept between 125 degrees and 160 degrees F. to favor the boiler feed temperatures, although at the expense of the vacuum, which runs from 20 inches to 24 inches. The higher temperature also saves condensing water.

There are two outlets from *B*, one an underflow at *E* into *C*, and one an overflow at *F* into *A*. The overflow at *F* is 3 inches lower than the one at *D* to insure a passage in and out of *B*.

The hot side, or pump suction side *C* is supplied from *B* through *E*. The temperature of this water is increased by returning to it, so far as possible, all steam drips, and pump, or other exhausts, raising its temperature to from 160 degrees to 180 degrees F. This gives a good start for a desirable feed water temperature, and at the same time saves many traps, together with their accompanying troubles and expense, insuring the return of the various drips with their British thermal units to the boilers. The only outlet from *C* is through the pump suction, and only such water enters *C* as is sufficient to supply the pump. Should the water at any time be cut off from *B*, then the supply would come automatically from *A* through *F*. The hot-well is provided with drain pipes in *A* and *C* for clean-out purposes.


5" PIPE FROM NO.2 ICE MACHINE
12" PIPE FROM NO.1 AND 2 POWER ENGINE
F
LOWER TANK OUTLET
TEMP. OF WATER =100° TO 120°
TEMP. OF WATER =125° TO 160°
TEMP. OF WATER =160° TO 180°
C
E
6" PIPE FROM NO.1 POWER ENGINE
D
A
B
6" DRAINAGE PIPE
5" PIPE FROM NO.1 ICE MACHINE
12" VENTILATOR TO ROOF
2" D.& M. TOP
OUTLET
ALL DRIP RUNS IN THIS SIDE AS SHOWN
TO HOT WELL PUMP
PUMP CYLINDER BELOW HOT WELL WATER LEVEL
Industrial Press, N.Y.

Figs. 1 and 2.

The water enters *B* at a comparatively high temperature, and any oil in the water will rise rapidly to the surface, while the oil from but one condenser is all that has to be taken care of. At the same time the flow of the water from *B* to *C* is very slow, giving ample time for the oil to rise to the surface and pass off through the overflow *F*.

Over 3,000 horse power of boilers, at one of Swift & Company's plant, are fed from this hot-well, and no sign of oil has been found in any of the boilers or their connections. The water from *C* has also been chemically analyzed a number of times, and but the slightest trace of oil has ever been found. The trace found was undoubtedly due to the oil coming in through a pump exhaust, and has in no way affected the practical working of the hot-well.

* * *

Elaborate tests have been made in England to determine the status of electric motors in coal mines, and the feasibility of employing them in dangerous mines in place of steam and compressed air motors. The tests show conclusively that the open type of direct-current, 500 volts, motor will cause explosions whenever immersed in a mixture of air and gas in the proportion of 9 of the former to 1 of the latter.

CUTTING TOOLS FOR PLANER AND LATHE.*

W. J. KAUP.

Planer tools will first come under our notice as being the simplest and requiring the least skill in setting. You have doubtless observed that if the chip be unwound from the spiral shape it assumes in leaving the tool, and projected in a straight line it is shorter than the surface from which it came. This is due mainly to the compression of the metal in the direction of the cut, and you will thus see the possibilities of saving power and strain upon the machine by giving proper cutting angles to the tools and reducing this compression to a minimum.

In Fig. 1 the cutting tool is at right angles to the work and without rake. It exerts its force in a direction nearly parallel to the surface of the work and having no side rake, either, it simply does not cut, but shoves or crowds the metal forward, producing a chip made up of little splints. It cannot exert any force tending to lift or curl the chip.

This tool is wholly wrong; nor would it materially improve it to grind like the tool shown in the little sketch at the right, which goes to the other extreme, and would spring into the work. A tool must first of all be heavy enough at the back or heel to resist the horizontal cutting force, and consequently should have very little clearance. The 7 degrees clearance shown in the lathe tool in the upper view, Fig. 2, is too much for a planer tool, while the 3 degrees of the lower sketch is as small as can be used safely. Theoretically if the point leads by only a thousandth or two it will perform its function. There should be very little top rake on account of its tendency to make the tool dig into the cut; but this can be compensated for by giving considerable side rake.

Another reason why a planer tool tends to dig into the work is illustrated in Fig. 3. Point *A* in each sketch is the fulcrum. In the first sketch the tendency is for the tool to dig into the work in the direction of the arrow. This is not so serious as appears on the face of it, as planer tools are usually so stiff that they will spring but little and any error that might occur in the roughing cut would be eliminated in the finishing cut. What many mechanics take as an indication of the spring of the tool is really due to the chatter of the planer; since a rack and pinion planer will frequently chatter after it has become worn, while in a worm-driven planer the lost motion is all taken up at one end before beginning the cut and the screw action does away with the chatter. To obviate any spring the tool may be designed as in the second sketch, Fig. 3, where the deflection due to the force of cut is away from the work in the direction of the arrow.

The tool in Fig. 4 approaches the ideal for a finishing tool, and gives the best finished surface of any that I have used on planer or shaper. It is made from a piece of ordinary tool steel and forged on the end in the shape indicated. It will be noticed that it has side rake and instead of being straight on the bottom, the line that comes in contact with the work is a little rounding.

We will now take up the subject of the cutting edges of some of the many varieties of lathe tools, Fig. 5. Here are shown a diamond point, a round-nose tool, a side tool, centering tool, thread-cutting tool, and cutting-off tool. We will first consider the diamond point as it is more of a universal tool than any of the others. Before speaking of rake, clearance or the setting of the tool I want to call attention to the general form of the cutting edges and the importance of maintaining the same throughout the life of the tool.

Fig. 7 will best illustrate my meaning. The tool is shown at the left with depth of cut, and ground so that angle x shall not be less than 55 degrees. To the right is a tool in which the angle has been changed by grinding on both sides of the point, only, because the machinist claims that he is in a hurry and must make time on his work. But it will be seen that the line of cut b is much greater than the line of resistance a, showing loss in efficiency in the tool and requiring more power to drive it after it had been ground. Nor is this the only reason why careless grinding will produce a loss, as I will proceed to prove.

This is true with proper rake, angles and clearances, but when the mechanic ignores all principles and is careless, besides, how much more serious it becomes, because more finishing cuts will be required to make the piece straight. The nearer the cutting edge of the tool comes to being parallel with the axis of the work the more power will be required to operate the tool.

It will be interesting to note what really takes place in turning, as shown in diagrammatic form in Fig. 8. Here is represented a piece of rough stock that is to be turned as indicated at the right. First, starting at the corner line *A*, and developing the line of circumference in a straight path, we will get a line like (1). After turning and repeating the process, the developed line will look like the line at (2). It will be noted that the second line is somewhat irregular, showing that even after roughing off, the surface of the piece has nearly all the irregularities of the rough stock, though on a smaller scale.

This brings us to another important point, and that is the necessity of centering work as accurately as possible, for no matter how even the work may be on its circumference, if centered out of true, it will not be round after turning. Why? Because the thickness of the chip or shaving is not uniform, hence does not offer uniform resistance to the cutting edge and the work will bend more at one point than the other. If the cut were uniform and offered the same resistance, of course we could expect round work.

The bottom figure on the sketch illustrates the tool and method of obtaining the lines. A long, light lever has a knife edge or point at one end, near the fulcrum, which bears against the periphery of the work. On the other end is a lead pencil attachment, the point bearing against the piece of paper indicated, the paper traveling at the same rate of speed as the work, only in the direction of the axis of the work. Any unevenness in the surface of the work raises or lowers the point of the pencil and as the ratio is great (20 to 1), the variation in the line is marked.

Referring to Fig. 2, we will take up the rake and clearance of lathe diamond point tools. The angle or clearance, sometimes called the angle of relief, as indicated here, is about 7 degrees, and sometimes runs to 10 degrees, more or less—enough for a safe working angle. Really the only reason for so much clearance is to avoid rubbing against the cut surface, thereby causing unnecessary frictional resistance to the motion of the lathe. Our efforts should be directed toward finding the angle that will give the least force required for cutting, combined with endurance of tool edge.

While the power required to cut is increased greatly by dullness of the cutting edge, we must avoid the wood chisel edge because time lost in constantly removing the tool for grinding purposes eats up the profit. In Fig. 9 are illustrated two extreme cases—that on the left, too great top rake and the other without any. The one will do good work for a few minutes, provided the cut is not too heavy, but the wear of the edge is so great that the angle would soon become blunt and it would be very much better to have no top rake at all. On the other hand, the cutting wedge, as I will call the tool ends on the right, is too blunt to do good, clean work, and from the position in which it is set, the chip will come off nearly straight and in small pieces. The happy medium between the two is indicated in Fig. 10.

Side rake means the angle at which the top is ground either to the right or left side. A tool ground for a traversing motion toward the left-hand, cannot be used with a motion toward the right. Therefore side rake is designated right-hand or left-hand, the former being that which has its cutting edge on the right side and the latter on the left side. As the side rake is increased, the power to drive it on in its traversing direction becomes less as it tends to screw its way along.

Fig. 11 illustrates an important point in setting the tool. The further the cutting edge is from the base, or support, the greater will be the spring. Where this spring is possible the point is drawn down into the work as indicated by the dotted line, and furthermore will produce irregularly-shaped work due to the variation in the resistance of cut at points where the tool digs in. This indicates the value of short leverage.

In Continental shops, and especially in England, it has be-

*During the last school year the author gave a series of lectures at Pratt's Institute, Brooklyn, before his evening classes in machine work. The accompanying article is an abstract of the lecture on cutting tools.—EDITOR.

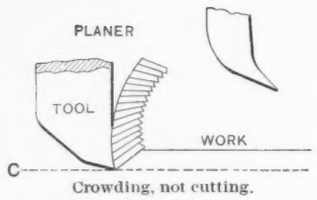


Fig. 1

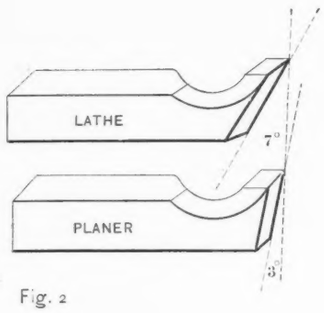


Fig. 2

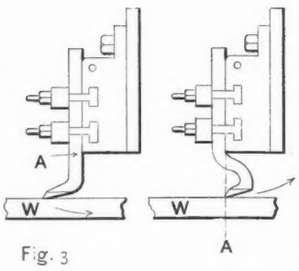
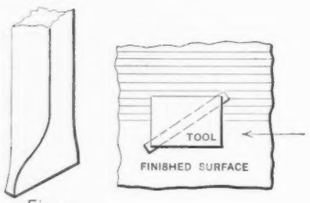


Fig. 3



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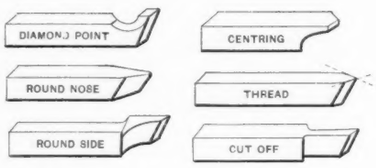


Fig. 5

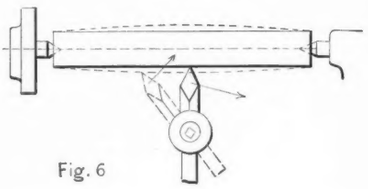
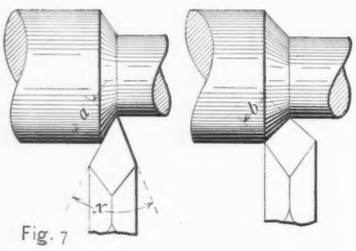


Fig. 6



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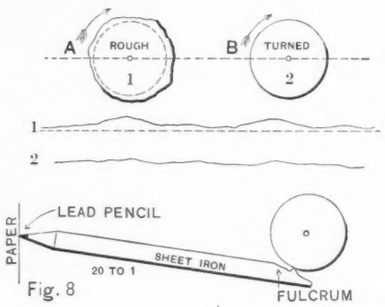

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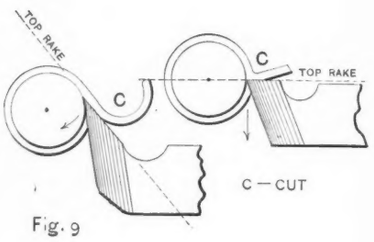


Fig. 9

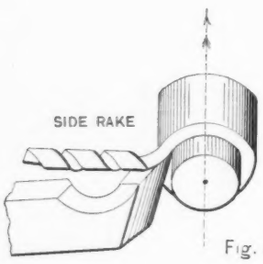


Fig. 10

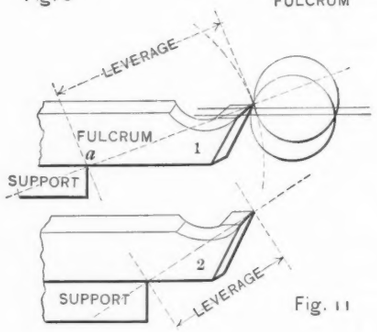


Fig. 11

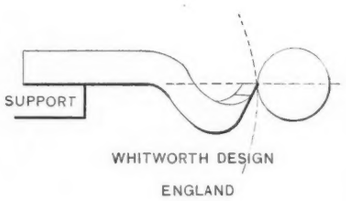


Fig. 12

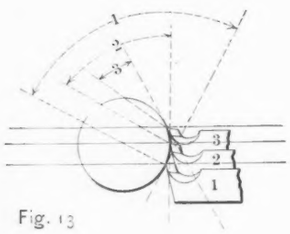
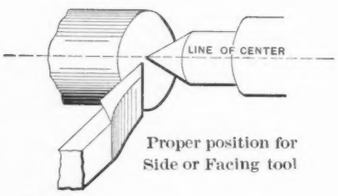


Fig. 13



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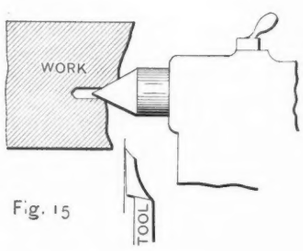

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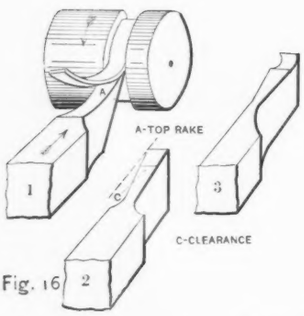

Fig. 16

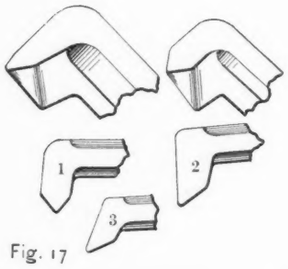

Fig. 17

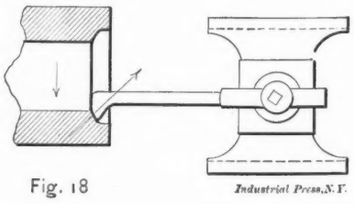

Fig. 18

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Reproduction of Lantern Slides Accompanying Lecture by W. J. Kaup.

come a recognized principle that the top of cutting edge of tool should not be higher than the top of the support and to obtain its top rake the tool is hollowed out by grinding. Sir Joseph Whitworth designed his lathes so that the tool set on the center of the work and any vertical pressure deflected the tool away from the work, as shown in Fig. 12.

Next in importance to the leverage of the tool is the angle at which it is set in relation to the work. Referring now to Fig. 6, the tool is shown at right angles to the work and the cutting pressure tends to force the tool around to the right, away from the work, in the direction of the arrow, instead of causing it to dig into the work. If the tool were set as shown in the dotted position it will readily be seen that any slipping or deflection would carry it into the cut.

The third point to be observed in regard to setting the tool is its height relative to the lathe centers. Fig. 13 illustrates this. Tool No. 1 is set below the center and the dotted line, drawn tangent to the point of the tool on the periphery of the circle, indicates the direction in which the cutting force is applied. The top or cutting surface of the tool forms an angle of 90 degrees with this line. The stock is thus merely crowded off by the tool and there is no cutting or wedge action whatever. The next tool is set on the center and has more of a wedge action, but still not what it should have. The top tool, No. 3, gives us the best cutting wedge and will do maximum work with minimum resistance.

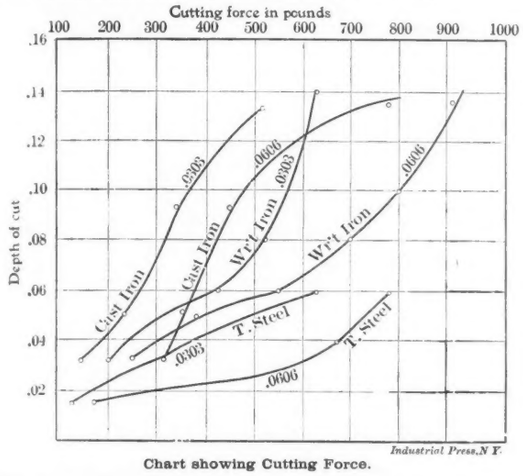


Chart showing Cutting Force.

From the foregoing it is clear that the lathe tool will do the best work with combination of top and side rake, when caught very short, at right angles to the work, and when set above the center. This will lead to economy.

Now a point about grinding: The diamond point tool should be ground only on the top, and the angles on the sides should never be touched, and there will be no danger then that you will destroy the economic value of the tool. Many mechanics burn the cutting edges of the tool in grinding, by simple carelessness, which makes the edge softer than the metal it is supposed to cut. My references thus far have been confined entirely to the solid tools, most commonly used. But there are many improved tool holders in use, designed for self-hardening steel which is not affected by burning in the hands of incompetent mechanics, either in grinding or through lack of knowledge of the proper cutting speeds. These holders support the steel in such a position as to give the proper front and side clearance and the rake is determined by the grinding.

Following is a table of finishing speeds and feeds for different metals for tools of ordinary tool steel. In roughing the axiom is slow speed and quick feed; finishing high speed and fine feed. From this table I should deduct 25 per cent. for roughing speed, making 18, 24, 28 and 83. Experiments on cutting tools made in the shops of R. H. Smith, London, England, and verified by the author, show that machine steel requires from two to two and one-half times the power for cutting, as does cast-iron, and wrought-iron about one and one-half times the power. The results are given in detail in the chart herewith and show that an increased force is required for increased cutting speed.

LATHE AND PLANER CUTTING SPEEDS AND FEEDS.

Tool Steel.		Wrought Iron. Machine Steel.		Cast Iron.		Brass.	
S	F	S	F	S	F	S	F
24	25	32	25	38	22	110	20
Lub.		Lub.		Dry.		Dry.	

F = Number of revolutions to 1 inch feed.
S = " " feet per minute.

The round nose tool, Fig. 5, is used for brass, when made rather pointed and for facing cast iron when it has a blunt point. The tendency with brass, which is very soft, would be to pull a hooked tool into the work. The side tool should always be set with the point leading slightly, but remembering that it is not the point but the side of the tool that is to do the cutting. This tool should be set on the center, as indicated in Fig. 14. Fig. 15 shows the necessity for facing up work with the side tool before turning; otherwise the center will give more support to one side of the work than the other and the pressure of the tool used later for turning will be likely to produce a crushing of the metal at the center, on the side of the least support.

The centering tool should be ground like a twist drill and placed with its cutting point directly at the center of the work and used to obtain an accurate center for starting a drill. Much carelessness is exhibited in the use of the thread cutting tool, not so much in grinding as in setting. It should be set so that the cutting edges are directly on the line of lathe centers and, of course, at right angles to it. The economical way to use this tool is to rough out the thread with a heavy cut and then regrind the top face until again sharp and then finish with a light cut. No matter how carefully a thread tool is used, the sharp point will wear rapidly.

Referring to Fig. 16, we come to the cutting-off tool, the last of the lathe tools shown in Fig. 5. The upper view shows the action of the tool and the two lower views indicate how good and poor results may be obtained through grinding. This tool has side clearance, right and left, and should be ground slightly concave on its top face. Its point should be on a level with the center of the work.

In Fig. 17 are indicated several of the commoner types of boring tools. The vertical pressure on boring tools is very nearly constant (Fig. 18), and when the tool starts to cut, the depression or spring downward remains very nearly constant throughout its entire cut, and so does not vitally affect accuracy. The tool wears as it advances, however, and this tends to produce a conical hole. Lathes are adjusted, also, so that in no case will they bore a hole larger at the back than at the front, and in making this adjustment the tendency is to have the lathe so it will bore very slightly smaller at the back —another reason why bored holes are frequently a little tapering.

* * *

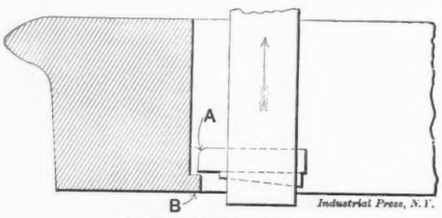
If the development of high-speed tool steel makes as much difference in the power required to drive machine tools during the next few years as it has since the advent of the Taylor-White process, we may soon look for the power plant of a moderate-sized machine shop to rival in extent that of a fair-sized central power station. When locomotive frame planers come to have electric motors of 80 H. P. and other tools in proportion, it is not too much to say that the future machine shop will require hundreds of horse power where tens sufficed a few years ago. As an illustration of the enormous motor equipment being applied to some minor tools we may mention that of an axle lathe recently built by Bement, Miles & Co. for the Howard Axle Works, Homestead, Pa. This machine is of the central-driven double-head type having four cutting tools. The driving gear in the center through which the axle passes, has an opening 12 inches in diameter, and the distance between the extreme centers, is 8 feet 4 inches. It is very solidly constructed and is, of course, a heavy tool for its class, but who would have anticipated the application of a 60 H. P. motor to drive it? Such is the case, however, a 60-H. P. motor being belted to a countershaft having 42-inch pulleys with 10-inch face and running at 360 revolutions per minute!

LETTERS UPON PRACTICAL SUBJECTS.

A TRICK IN BORING TIRES.

Editor MACHINERY:

Some time ago I was in a railway shop where rapid work is being done on a boring mill—boring locomotive tires. A well-known brand of high-speed steel was used for the boring cutter, and the cuts were run through with a heavy feed and at three or four times the speed that would be possible with ordinary tool steel. Each tire was bored at two cuts, but near the end of the finishing cut it was necessary to change the cutter having a rounded lip for one having a square lip so as to square up a shoulder *B* shown in the accompanying cut. This shoulder or lip bears against the wheel center and acts as a sort of retaining ring to prevent the tire slipping inward when the locomotive is rounding a curve, etc. When



Boring Locomotive Tires.

using the square edged cutter it is necessary to run at a somewhat lower speed and this materially increases the time required for finishing each tire, although the total time required is only a little more than an hour for a 68-inch tire.

It seems to me that the change of cutter necessary when feeding downward could be avoided in this case by the simple expedient of feeding upward. The cutter being ground with a square corner on the lower side and rounded on the upper side at *A*, would be well suited for finishing the job without change. Starting the cut at the shoulder, the cutter would be fed into the cut by the cross feed until the required depth was attained. Then the longitudinal feed should be thrown in and the tire bored at the maximum rate without any "nursing" whatever.

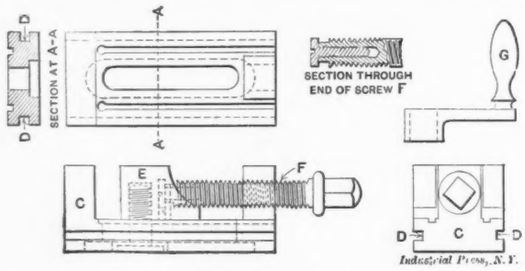
F. EMERSON.

Newark, N. J.

A HANDY TOOLMAKERS' VISE.

Editor MACHINERY:

We all know how difficult it is at times to handle small pieces of work accurately, it often being necessary to solder them onto a plate in order to do any kind of work upon them. Any one having much of this kind of work to perform will therefore appreciate such a vise as is shown in the accompanying sketch and which I have made for holding small pieces to be operated upon. It is not like the regular vises which may be purchased, in that it may fairly be classed as an



Toolmakers' Vise.

accurate tool. It is not only made for use on the drill press but may be used on any side or end as the work makes most convenient, since it is made perfectly square and parallel on all sides. The sketch is just half size and requires but little explanation.

C is the body, made of machinery steel and case-hardened. The slots *D D*, along the sides, are used for clamping the vise down or for swinging it upon a faceplate. The movable jaw *E* is likewise made of machinery steel and case-hardened. The screw *F* is 5-16 inch in diameter, cut with 20 threads per inch, and has a No. 8-40 screw in the end, the head of which works in a T-slot in the movable jaw, thus forcing it forward or drawing it back. Both screws are spring tempered and lapped to a perfect fit. The end of the larger screw is squared off and to it is nicely fitted the wrench *G*. All parts are lapped accurately so that drilling holes, or milling and planing faces, at right angles with each other can be accurately accomplished by its use. I have found it one of my handiest accurate tools but it must be very carefully and accurately made, otherwise it will be no better than any of the vises that may be purchased.

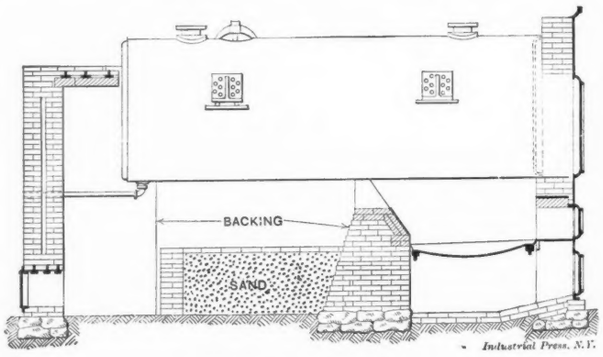
J. M. S.

REGARDING BOILER SETTINGS.

Editor MACHINERY:

Regarding the sketch of a boiler setting, shown by Mr. Perrigo in the May number of MACHINERY, there is one point that is of considerable importance in the economical working of the boiler which has not been mentioned. This is the building up back of the bridge wall so as to form a prolonged combustion chamber in which the gases may be more thoroughly burned than would be the case if the bridge wall was not backed up; for it is a well-known fact that combustion is not completed in the furnace but continues after the gases pass over the bridge wall on their way to the stack. This fact was forcibly called to mind by two cases which recently came to the writer's attention in connection with power plants.

A new plant had been supplied with a battery of boilers, two to be used constantly while the third was to be held in reserve. After running for some time with two boilers it was found necessary, on account of extra work, to place the



A Backing for the Boiler Setting.

third in commission, but even with the most careful handling and well-managed firing it was impossible to make the third boiler steam as efficiently as the other two. After running for a while, however, its steaming capacity came up to that of the others. The reason of this action was the filling up, to some extent, of the space back of the bridge wall with ashes and thus forming a better combustion chamber. While the steaming was improved by the ash filling, it was not what it would have been with a properly designed combustion chamber.

Another case in point, which illustrated more clearly the economic value of building back, was that of a set of boilers which were supplied with the ordinary bridges. After a time the consulting engineer became dissatisfied with the running of these boilers, and backings were built behind the bridge walls. These boilers were run night and day and by putting in the backings a saving of five hundred pounds of coal was effected in twenty-four hours.

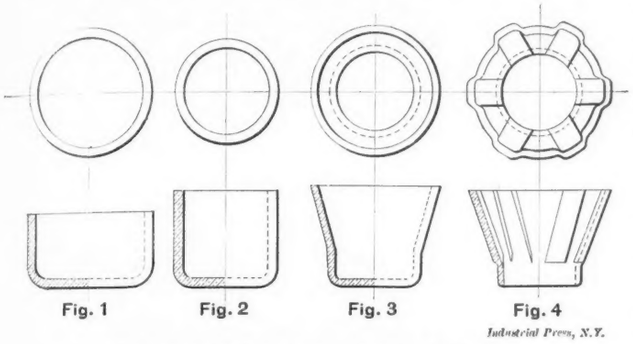
This matter appears to be of so great importance that it should not be neglected in the design of a boiler setting. The accompanying sketch shows the boiler setting referred to in Mr. Perrigo's article, to which has been added a brick and sand backing which would, I am sure, add considerably to the efficiency of the boiler.

J. A. P.

PUNCHES AND DIES FOR DRAWING AN ODD SHAPED BRASS CUP.

Editor MACHINERY:

The set of punches and dies here described, while not exceptionally out of the ordinary, may have one or two points that will be of interest to any one engaged in this class of work, and my experience in producing the punch by which the final operation was performed may prove of assistance to some one having a similar punch to make. The sketches, Figs. 1 to 4, show the progressive operations from start to



The Successive Operations for Drawing Brass Cup.

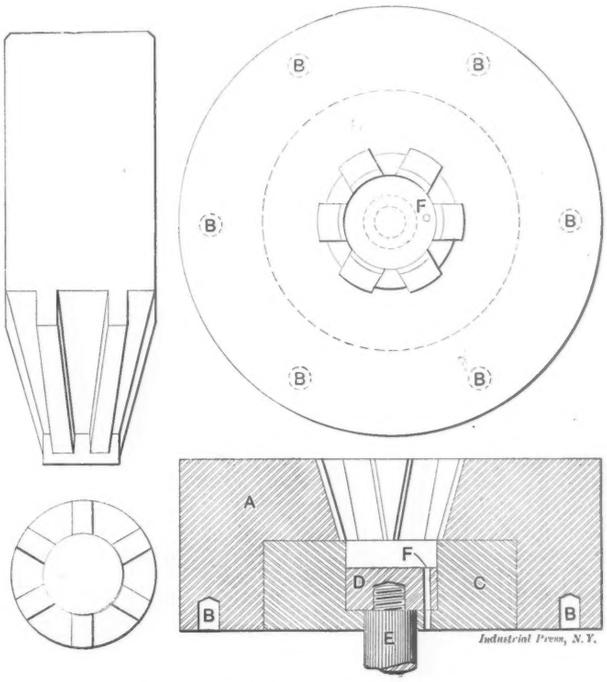
finish by which the piece shown in Fig. 4 was produced. This is a corrugated, conical cup, drawn from a round blank of soft brass 3-32 inch thick and 2 5-16 inches in diameter. The corrugations project externally, and internally form six equally spaced, square grooves which converge radially and disappear within about 3-16 inch of the bottom. The specifications in this case required that there should be developed on the outside a distinct shoulder at the base of the conical part and that this shoulder be formed on the corrugations only. On the inside no shoulder should be visible but the formed grooves be made to disappear uninterruptedly near the bottom. It will be seen that the pressure in the last drawing had to be much greater than ordinary in order to accomplish these results, for the stock at the point where the straight and conical portions met was pressed out quite thin in order to develop the shoulder.

The dies and the shanks of all of the punches used were made of a uniform size so that two holders, one for the punches and one for the dies, were all that were required. The punches were secured by a setscrew and the dies were seated in the holder and held fast by four setscrews, equally spaced around the side, with their points set into the circumference of the dies. To make the change from one operation to the other it was only necessary to loosen the screws, remove the tools in use, and substitute the ones next in the set. Each drawing operation was followed by a careful annealing in order to insure the equal flow of the metal and to minimize any possibility of cracking.

The main problem was to make the finishing punch as cheaply as possible and have it stand up under the severe work required of it. It was first made in sections by turning it to shape and then dovetailing to receive the elevated pieces which were made separately and forced into the dovetails up against a shoulder. Then the end was drilled and tapped and the straight tip screwed on. The parts having been carefully fitted were marked, removed and hardened, and then replaced as before. The punch made in this way had been used for a short time when the elevated pieces began to chip and crack, where the strain was the greatest, and often one hundred or more cups would be run through before the defect was noticed. For this reason the hardened sections were replaced by soft ones, but after a short run they would flatten down and make continual repairing necessary. To overcome the trouble the punch was finally made as shown in Fig. 5, from a solid piece of tool steel. This was milled, chipped, and filed to a finish and after hardening was drawn to a light straw color. After this no more trouble was experienced.

The first and second drawing dies were made from tool steel disks, 5 inches in diameter and 2 inches thick, with holes to draw the cups as shown in Figs. 1 and 2. These dies were of the plain push-through type with a sharp edge on the under side to strip the work from the punch which was made slightly tapering and of a diameter equal to the inside of the cup. In this case the punch was made two thicknesses of the stock plus .008 inch, less than the hole in the die. Previous to the last operation it is general to make the punches more than twice the thickness of the stock smaller than the die and to taper them ⅛ inch per foot to assist in stripping the work, for in most cases the exact sizing of drawn work is of little importance up to the last operation. Consequently tapering the punch and making it below size will in no way interfere with the finishing of the work which is all done in the last operation by a punch and die that must be made of suitable dimensions to meet the requirements. The rule usually adopted is to make the punch small and tapering for short cups of thick metal and nearer to size for thin stock, for the latter is more apt to develop body wrinkles if not properly pressed out in the die. The die for the third operation is made the size of the finishing die but with plain walls.

The die for producing the finished work is shown in Fig. 6. The part *A* was first turned and bored in the lathe and then fastened on a special arbor fitted to the spindle of the dividing head of a milling machine. Six ¼-inch holes were drilled and reamed, as at *B B*, the piece being indexed so that they would be accurately spaced. A special angle iron was made for holding this piece at the angle of the sides of the die, and two holes were carefully drilled in its face to correspond with a diametrically opposite pair of the drilled holes in the back of the die. In these holes were driven ¼-inch guide pins which projected 3-16 inch above the face of the angle iron. The angle iron was then bolted to the knee of a shaper



Figs. 5 and 6. Punch and Die for the last Operation.

and the die located on its face, by the pins, and strapped firm and true. The six drilled holes provided a means for accurately locating the die for planing the grooves, which was done with a formed tool screwed on the end of an extension shaper tool of the kind usually used for internal work. After shaping, the grooves were filed and polished dead smooth and the die was hardened. The piece *C* was turned and ground to a light driving fit in the back of the die and both pieces surfaced on the under side. *D* is a steel pad and *E* a stud for stripping the finished work. They are operated by the press ram on its upward stroke. The vent *F* is for the escape of air. Following the drawing of the cup the bottom was punched out in a plain cutting die.

C. H. Rowe.

Salem, Mass.

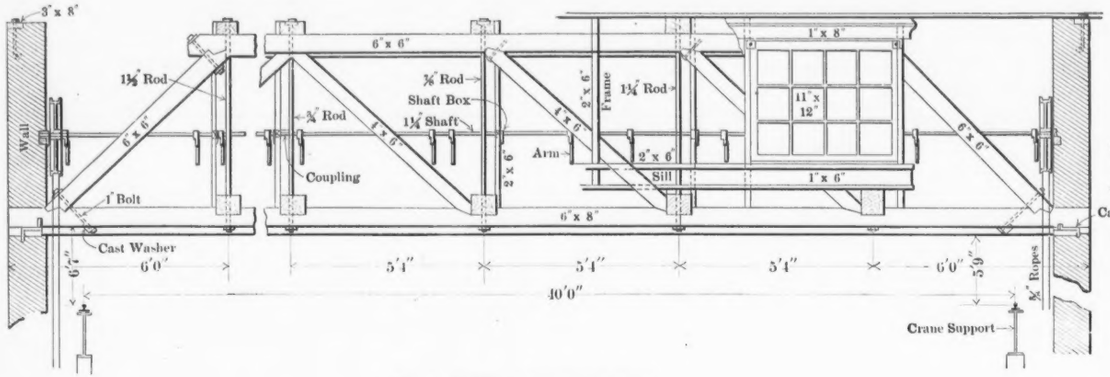


Fig. 1. Truss of Saw Tooth Roof.

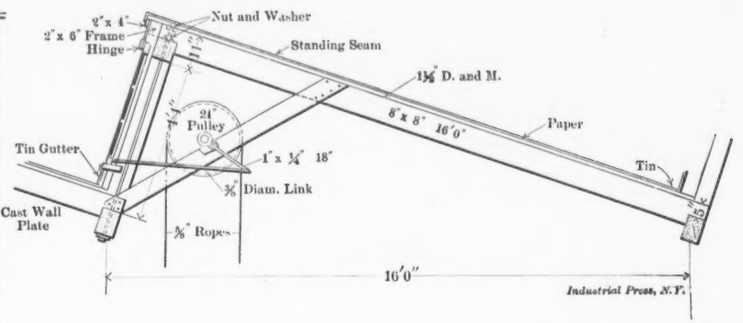


Fig. 2. Section through Wooden Saw Tooth Roof.

WOODEN SAW TOOTH ROOF.

Editor MACHINERY:

Never having seen the description of a saw tooth roof of wooden construction, and but few of steel, I think the following description may be of interest in connection with the articles on shop construction, recently published in MACHINERY. That the saw tooth roof possesses many advantages is attested by the number of cases in which it is employed in the construction of the most up-to-date shops. Most of these are steel buildings but it is perfectly practical to use this style of roof for wooden buildings as well. The cuts illustrate a wooden roof of this construction and incidentally show a truss over a craneway and also a window-operating device that is comparatively inexpensive.

The truss and roof details are quite clearly shown but a few points may be noted in explanation. The side walls have buttresses on the outside to keep the craneway in line but in addition to these it is considered desirable to have the trusses assist in keeping the track in place. With this end in view, cast iron wall plates, of the type shown, are employed. These plates have a projecting flange extending down into the wall about 3½ inches and on the upper face is a rib, 1 inch high, placed at an angle. The timber is mortised out somewhat wider than the space occupied by the rib, and when the truss has been placed on the wall plate, hard-wood keys are driven in on either side thus keying the lower chord in position in an easy and economical manner.

As may be seen in Fig. 2, the truss tie rods have a long thread on the upper end which is for the purpose of convenience in erection. The truss is framed and brought up to tension on the ground, then raised in position and the rafters placed on top, after which the second nut and washer are put on the end of the rod and drawn up. The rafter is countersunk for the first washer and nut and for as much of the second one as will not be taken care of by the thickness of the roof. In order that the countersink be as shallow as possible, the washers are made of ⅜ inch steel, being cut from ⅜ x 3-inch steel plate. The lower end of the rafter is slotted to allow it to be placed on the tie rod at the bottom chord and after it is in place a piece is fitted into this slot, more for appearance than for any real use. The rafters are shouldered down at both ends to take the thrust due to the inclined position of the truss and roof. The trusses are placed at an angle for two reasons: First, because the theoretical distribution of the light is better, and second, because there will be less waste of lumber as the rafters can be made from 16-foot sticks.

To provide for the proper drainage, the entire roof is placed 10 inches higher on one side than on the other, as shown by the clearance from the crane rails. This gives a slope of about ¼ inch per foot and has proved very satisfactory. The roofing is standing seam steel laid on tarred paper, the paper being coated with hot roofing pitch before the roofing is applied. The gutter is made of tin flashed up onto the window sills. The window frames were made by spiking 2 x 6-inch stock onto the face of the trusses and cutting in the window sills, the sash being flush with the edge of the 2 x 6-inch pieces. Stops are placed on the sills and can be placed on the sides also, if thought best, although we have had no trouble by the rain beating in at this point. The hinges are made from 1¼ x 1¼-inch angles, holes being punched in one end for wood screws and in the other for ½-inch machine bolts. The angles were fastened to the 2 x 6-inch pieces and to the sashes, the machine bolt forming the fulcrum. The hinges are, of course, placed as high as possible and the windows are operated by the mechanism shown in the drawing. One-half of the windows in each tooth are operated by each set of mechanism. A ⅝-inch rope is wound around a 24-inch pulley mounted on the end of the operating shaft, the ropes passing down outside of the crane rail. The shaft is 1¼-inch rough stock and the bearings, arms, etc., are cored 3-32-inch large and attached by setscrews. The two lengths of shaft for each tooth are placed in line, a coupling being fastened to the end of one and the end of the other being a loose fit in this coupling. The supports are cast to rest upon 2 x 6-inch braces which also serve to strengthen the roof to which they are fastened with wood screws. The arms are fastened to the operating shaft by means of setscrews passing through their hubs.

The link which connects the arms with the sashes are of ⅜-inch rough rod, one end of which is given a short turn and passed through the arm and held in place by a cotter pin. The other end passes through a screw eye fastened to the lower part of the sash and is likewise held in place by a cotter. As shown on the drawing, the arms have to be set so as to allow the links to clear the diagonals of the truss; in fact this seems to be the only real objection to having the diagonals come in front of the windows, and this in no way affects their operation. This saw tooth roof is the second that has been built from this design and it has proved entirely satisfactory.

C. J. MITCHELL.

Beloit, Wis.

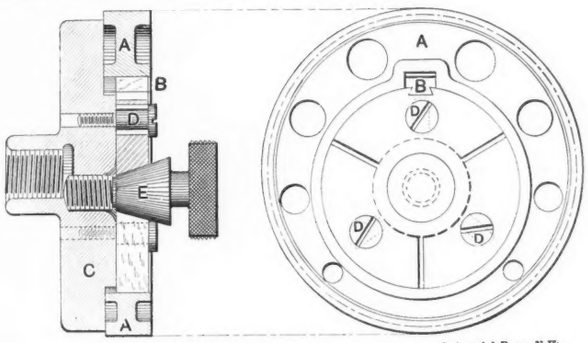
MACHINING AN ECCENTRIC RING.

Editor MACHINERY:

In a jobbing shop in which I was employed an order was secured for a large number of eccentric brass rings of the shape and section shown at *A* in the accompanying figure. They were to be bored out, faced on both sides and turned on

the periphery, all dimensions being made to gage so that the pieces would be interchangeable. In order to turn out the work at a profit it was necessary to design and build a few fixtures for the rapid handling of the pieces. Two chucks were made for this purpose. The first, which held the ring while the eccentric hole was bored and one side faced, was of no especial interest so it is not described. After this operation the keyway at *B* was machined with the aid of a simple slotting fixture.

The chuck that was employed for the last operation, that of turning the periphery and facing the remaining side, possessed several features of general interest that might be adapted to other work of a similar nature. This chuck is shown in the cut, holding one of the rings in position to be operated upon. The body of the chuck, *C*, was threaded to screw onto the spindle of the lathe and carried on its face three expanding and contracting segments for holding and truing the ring, one of them being provided with a key which fitted the keyway *B* for locating and driving the ring. These segments were held to the faceplate by three shoulder screws *D*, *D*, *D*, which passed through radial slots, thereby allowing the segments an in-and-out movement across the face of the chuck. This expanding movement was imparted to the segments by means of the knurled head expanding screw *E* which was tapered to fit the tapered hole in the inside of the segments. The outside of the segments was tapered slightly so that the tendency, when they were tightened or expanded, would be to force the work against the faceplate. The clamping surfaces were eased off so that only about one inch of each would bind against the work.



Industrial Press, N.Y.

Chuck for Turning Eccentric Rings.

The manner in which the chuck was used and the work machined was as follows: The stud *E* being screwed outward by grasping its knurled head, the segments were contracted. Then the ring was located against the faceplate with the key in the segment fitting the keyway *B*. The expanding stud was screwed in and the segments in expanding forced the work against the faceplate and held it securely. It was then a simple matter to turn the periphery to the required diameter and face the side, after which the segments were contracted, by unscrewing the expander, the finished piece was removed and another one located ready for machining. As will be understood, the machining of the rings with the usual means handy around a jobbing shop would have been difficult and would have consumed much time; while by this method there was no time lost and the complete interchangeability of the rings when finished was guaranteed. It was surprising how easily and rapidly the rings were located and removed and how tightly they were held. As the brass castings from which the rings were finished were not of the best quality, and were sandy and scaly, a cut of considerable depth had to be taken, thus putting considerable strain on the segments.

LATHESMAN.

SOME CONVENIENT LAPS FOR SHOP USE.

Editor MACHINERY:

The accompanying sketches illustrate some laps that were used in the grinding department of a shop with which the writer was recently connected. The lap shown in Fig. 1 was a plate of cast iron which was first scraped to a smooth surface, after which parallel grooves, 1-16 inch wide by 1-32 inch deep were cut upon the surface, forming small divisions ⅜ inch square. This plate was charged with fine emery and turpentine and when used on keyseat gages, or other flat pieces, was capable of producing a very fine surface.

Fig. 2 shows a lap formed of a smooth turned piece of hard wood onto each end of which was fitted a ferrule of wrought iron to prevent splitting. A narrow slot was sawed through the center and into this was driven a wooden wedge to compensate for wear. One of these laps would last for a long time and they were used on milling cutters when the amount of stock to be removed from the holes was not sufficient to warrant the use of the grinder. The lap shown in Fig. 3 was a cast iron cylinder that was bored to fit the arbor with which it was to be used. Three strips of lead were dovetailed across the surface and these carried the charge of emery and turpentine or oil. Three small tapered holes were drilled and reamed longitudinally and tapped at the small end to receive the taper expanding screws. After these were fitted, diagonal slots, which intersected the holes, were cut, so that by a slight turn of the taper screws the lap could be expanded to adjust it for wear. This lap was used on the inside of ring gages.

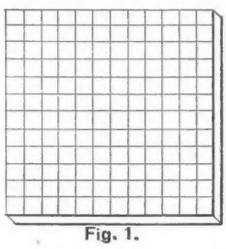


Fig. 1.

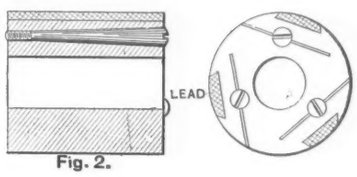


Fig. 2.

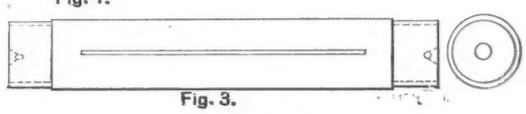


Fig. 3.

Flat and Internal Laps.

For lapping the outside of plug gages we used the lap shown in Fig. 4, which consisted of a casting bored out to the required size and fitted with three wide strips of lead. A slot was cut through the lug on the upper side, and this was fitted with a pair of setscrews to form the means of adjustment. A handle was provided to prevent the lap from turning while the plug gage upon which it was being used was revolved in the machine.

Under the subject of lapping might be mentioned a little job that appeared to the writer to be rather novel. A shop mate had a pair of micrometers, the faces of which had become considerably worn. He procured a small piece of plate glass and placed a few drops of oil and flour of emery upon one side, while the other remained perfectly clean. The micrometers were then closed lightly upon the glass, which was slid back and forth between the jaws for quite a little time. Then, after thoroughly cleaning the first jaw, the glass was reversed and the process repeated upon the other jaw. In a short time the micrometers, so far as the jaws were concerned, were as good as ever.

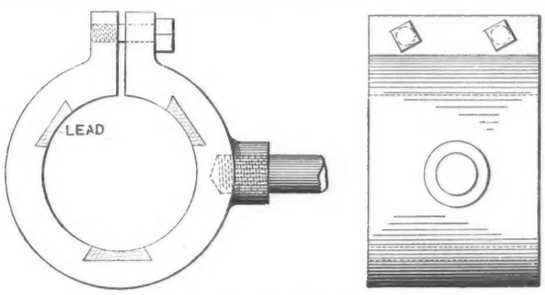


Fig. 4. Lap for Plug Gages.

ROY W. HARRIS.

Salem, Ohio.

FIXTURES FOR MULTIPLE MILLING.

Editor MACHINERY:

Sometimes a simple operation like splitting a piece of work in two will be found to present difficulties equal to those encountered in much more complicated operations. One

such a case was met with in machining the pieces shown in Fig. 1, which were to be split in two along the line *X Y*. Owing to the peculiar shape of these pieces it was impossible to clamp them in any position so as to mill more than a single one at a time and as a large quantity were to be made it was desirable to arrange so as to cut a number at a single operation. For this purpose the jig shown in Fig. 2 was constructed and with this ten pieces could be cut at a single setting.

This fixture consisted of a casting *A* which was provided with a tongue for aligning it upon a milling machine table, and a slot at either end for receiving a clamping bolt. A series of holes, of the same size as that in the work, was drilled in the upper part of the fixture, and to insure their being parallel with the tongue, the drilling was done in place upon the milling machine, the vertical attachment being used. These holes were fitted with the studs *B B*, which were of sufficient length to extend through the work *C*, as shown in the section. On the bottom of each stud was placed a split washer and nut, the latter being small enough to pass through the hole in the jig and work. These studs were prevented from turning, when the nut was tightened, by

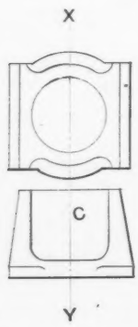
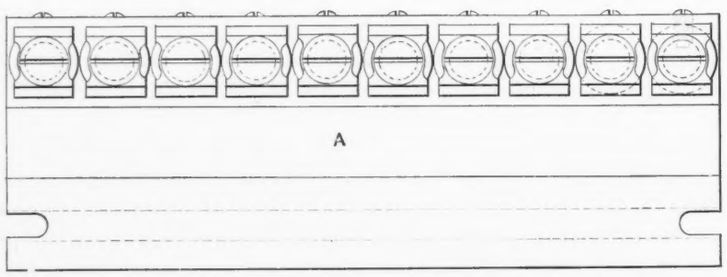


Fig. 1. One of the Pieces.



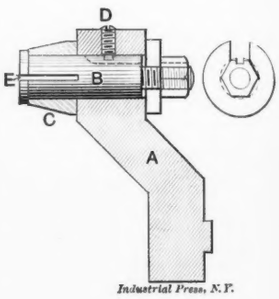


Fig. 2. Fixture for Splitting ten Pieces at once.

means of a setscrew *D*, the point of which fitted a slot in the side of the stud. A similar slot was also cut in the side of the nut so that it could pass the setscrew. A slot *E*, the width of the splitting saw, was cut through the top of each stud and the setscrew *D* insured this slot being always in proper position for the saw to pass through when splitting the boxes.

Before the pieces were placed in the jig they were bored and faced on the top, bottom and on the straight sides, so that the splitting formed the last operation. Ten of the pieces were placed on the fixture, the bolts *B* put through and the washers put in place. Before tightening the nuts a straightedge was placed along the front side of the pieces so as to set them all squarely, after which the nuts were tightened and the saw passed through the group in the usual manner.

CHARLES P. THIEL.

Lawrence, Mass.

THE PRINCIPLES OF PSEUDO-PERSPECTIVE IN PRACTICE.

Editor MACHINERY:

The article in the July number of MACHINERY entitled "The Theory and Application of the Principles of Isometric Drawing," by A. B. Babbitt is undoubtedly in keeping with the tendency of the times in modern drafting room practice. The importance that was formerly placed on true perspective is, or should be, fast disappearing in practice, as the camera, with proper manipulation, will do a far better job than any artificial mechanical method. In the commercial working, drawing with the usual orthographic representation of the object, a large number of meaningless conventions used for picture effects and mis-called "systems" are being replaced by heavier and plainer lines which are described by unmistakable dimensions and good every-day Anglo-Saxon; all of which things are in harmony with this most practical age. The spirit of commercial drafting is to make a working drawing of an object clear and well represented, with a minimum number of lines and views; hence, in the average practice a symmetrical object is often satisfactorily shown in one view while, on the other hand, an intricate angular object will require several views.

Recently some few commercial drawings have been seen which made use of the pseudo-perspective projection, which gave a clearer conception of the form of the object than an orthographic projection would have done, and with no greater expenditure of time than there would have been in making the several necessary views in orthographic. Patent Office drawings, especially when the invention is illustrated in the Patent Office Gazette, require occasionally a descriptive view of the object which cannot be shown in orthographic projection. Perspective or pseudo-perspective must then be resorted to and the latter will save much time if mechanical means are used. The article referred to has, in isometric projection, treated only one species of pseudo-perspective. Omitting a descriptive of geometry definition, it may be said that all projections, when referred to and governed by the position of axes would come under the term axometric projection. Thus isometric projection is defined if the axes are taken at 120 deg. with each other regardless of what angle any one of the axes makes with the vertical or horizontal. Cabinet projection is specifically defined by the angles that the axes make with each other, which are 90 deg. and 45 deg., and their position should be horizontal and vertical and with the 45 deg. line half the true length of the corresponding line in the object. Axes can be selected which make any angle with each other and take any position with reference to a horizontal or vertical, with results which are sometimes as satisfactory as the conventional isometric. However, the axes should be selected with reference to convenience in drawing the lines, which fact would indicate that horizontal, vertical, 15 deg., 30 deg., 45 deg., 60 deg., and 75 deg. lines are to be selected in some combination of three, on account of the gain in convenience in the use of the triangles and T-squares. The proper combination to suit each case belongs more properly to the science of descriptive geometry or to the art of the skilled draftsman.

There is occasionally found among draftsmen an artist who needs no axes and consequently no knowledge of axometric projection but, with a free hand, can lay in his lines to better effect than his brother draftsman who uses mechanical means. He, however, loses the great advantage which is sometimes gained by drawing to a working scale in axometric. After the axes have been selected, the fundamental rule that all parallel lines in the object are parallel in the drawing must be observed, unless a better picture effect is sought, which will occur quite infrequently.

C. E. COOLIDGE.

Ithaca, N. Y.

* * *

In the case of most cast-iron machine parts that have to go through the operations of planing, boring, drilling, etc., the usual procedure is to first plane the piece and then do the other operations, as then there are truly plane surfaces to work to. This, however, only holds when the holes to be bored are relatively small as compared with the size of the piece. When there is only one bore of large relative size like that of a steam cylinder, the cylinder is first bored and then planed. This is especially true of the practice followed in making locomotive cylinders. The boring bar must be set with special reference to the cored hole so that it will clean up, and the planing surfaces, which are certain distances from the bore, must take care of themselves.

ITEMS OF MECHANICAL INTEREST.

MAMMOTH STEEL FREIGHT CAR—OFFICE TELEPHONE SUPPORT—STEEL ELEVATOR GUIDE—PERMANENT IRON MOLDS—ADJUSTABLE SOCKET WRENCH.

It appears that bolts, nuts and other ordinary screwed connections traversed by an alternating electric current, are very likely to loosen in time even if so situated as to be unaffected by the ordinary mechanical vibrations of running machinery. The cause for this phenomenon seems obscure, as no satisfactory explanation has ever been made of it so far as we know.

Experiments by J. Parker Whitney in Oregon upon the preservation of food products by freezing, indicate that live fish may be frozen and thawed back to life again if not exposed to the sun or allowed to get more than 12 to 14 degrees below the freezing point. If exposed to zero temperature they will not survive as the faint pulsations of life then cease. This has led to a project for the shipment of live salmon to the Atlantic coast and we may yet have planked live salmon in New York City.

A valuable feature of the electric motor where it is coupled direct to a shaft having end thrust, is that it may be so designed that the magnetic pull of the field coils upon the armature shall be longitudinal to its axis as well as tangent to its periphery. The longitudinal pull may be so proportioned as to entirely balance the end thrust, provided it is not too great, of course, and in this way the loss due to the friction of a thrust bearing may be eliminated. This feature of the electric motor is of special value in high-speed machinery like office fans, and it is in them that the principle is largely employed. The end thrust due to the fan action is not great, but the fan revolves at high speed, and if there was the friction of a thrust bearing to overcome, the mechanical efficiency would be considerably reduced.

Several times within the past few months we have referred to certain nickel-steel alloys (about 36 per cent. nickel), having a very low coefficient of expansion, say, one-thirteenth that of steel. But M. Guillaume, assistant director of the International Bureau of Weights and Measures, who has been for several years making a special study of these alloys, now states that nickel-steel wire has been made having so slight a degree of extensibility within the ordinary ranges of temperature, that this is only discoverable with very accurate means of measurement. Between the temperatures of 32 and 68 degrees Fahrenheit the expansion is said to be only about one-fortieth of an inch in one mile length. It is also stated that a nickel-steel alloy has been made that actually contracts with heat like rubber, but this is presumably true only within narrow limits.

When the trains were first started on the Boston Elevated railroad there were many complaints because of the noise made by them in passing over the elevated structure. This noise was louder and more objectionable than experienced with the elevated trains in New York City. In Berlin, Germany, there has been similar trouble and the railroad company has been compelled, through legal measures, to resort to every practicable means for reducing the vibration and deadening the roar of traffic. Experiments were conducted which included, first, inserting three layers of felt between the rails and the wooden ties on which they were laid. This did not satisfy the complainants, although it made some improvement. Next, in place of wooden sleepers, hollow iron girders were put beneath the rails and filled with loose sand, which, it was expected, would take up the vibration and thus deaden the shock. This, also, has been found partially effective, but not wholly satisfactory. A third plan has been to abandon the use of cross-ties and instead lay the rails on long longitudinal wooden sleepers, with cushions of lead laid beneath the rails. Finally, the car wheels have been in some way lined with wood, so as to break the continuity and consequent resonance or a metallic structure. All these experimental remedies are still on trial, but no definite conclusion concerning them has been announced.

STEEL FREIGHT CAR OF 300,000 POUNDS CAPACITY.

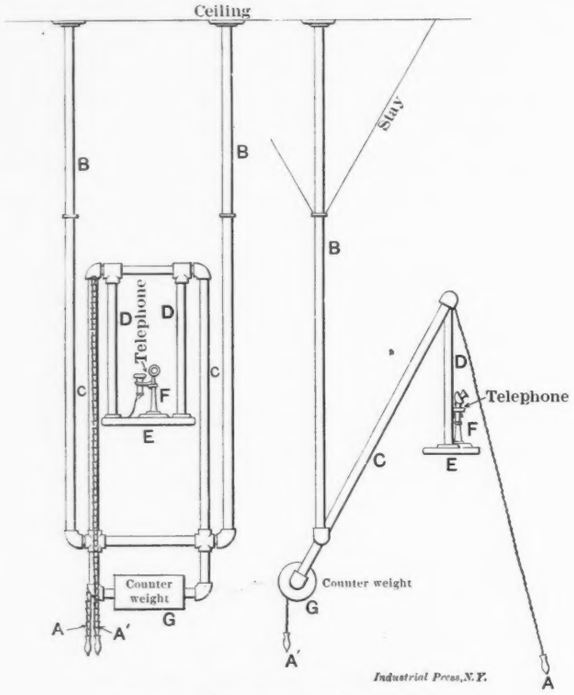
A cut appeared in the June issue showing the boring of the bolt holes in a huge steel casting weighing about 250,000 pounds at the works of the Bethlehem Steel Co. This casting is one forming part of a 12,000-ton armor plate forging press being built by this company for the Carnegie Steel Co. In the same connection mention was made of a special freight car being built for the purpose of transporting these enormous castings, one of which weighs 325,000 pounds, to Pittsburg. The accompanying cut, Fig. 1, shows a view of the car, which has since been completed and dispatched with a load of two smaller castings, the aggregate weight of which was 277,000 pounds. The length of each casting is 21 feet 4 inches; width, 2 feet 8 inches; height, 11 feet 6 inches. The large casting shown in the June issue is 24 feet 4 inches long; 5 feet 2 inches wide, and 13 feet 2¼ inches high. The large dimensions, especially the height, made it imperative to provide a special car, fully as much as the great weight. To clear bridges and tunnels it is necessary that the castings be carried vertically, and to accomplish this the body of the car consists of two steel trusses, 66 feet 10 inches long and 6 feet high, between which the load is swung. The trusses are supported at each end by two sets of eight-wheeled trucks, making 32 wheels in all. The main trusses are pivoted on king-bolts which are 64 feet apart center to center, and the short trusses or equalizers at the ends, distribute the load to the centers of the eight-wheeled trucks, which are also pivoted on king-bolts. The trucks themselves are provided with springs and equalizers so that the load is uniformly distributed among the 32 wheels.

Fig. 1. Steel Freight Car of 300,000 Pounds Capacity.

The total length of the car is 103 feet 10½ inches; height, 10 feet 2¼ inches; width, 9 feet 9 inches; weight, 196,420 pounds; capacity, 300,000 pounds. The car was built by the Bethlehem Steel Co., at South Bethlehem, Pa.

CONVENIENT OFFICE TELEPHONE SUPPORT.

There are quite a variety of telephone supports for desk use, good, bad and indifferent, but the most novel and in some respects the most convenient we have seen is a home-made affair in the private office of the Detrick & Harvey Machine Co., Baltimore, Md. A double flat desk is used for the two partners and it was necessary to arrange the support so that the telephone would be equally accessible for both. The illustrations, Figs. 2 and 3, show front and side views of the construction so clearly that little description is required. The frame is constructed entirely of pipe and pipe fittings, the side members *B B* being one-half inch size. The upper ends



Figs. 2 and 3. Office Telephone Support.

of these pieces are fastened to the ceiling directly over the center of the flat-top desk and are stayed by wires. Pivoted on the cross-bar at the bottom is a closed frame *C C* having a counterweight *G* at the bottom. The telephone support is composed of a board *E* upon which the instrument *F* is set, and the pipe members *D D*, which are pivoted on the upper cross-bar. Two flat link chains *A A'* are oppositely attached to the upper end of the counterweighted frame to pull the telephone down to the level of the user. Fig. 2 shows the frame being swung down by the chain *A*.

A COMPRESSED STEEL ELEVATOR GUIDE.

In the erection of elevators much trouble is ofttimes experienced in procuring proper guides for the cars, while recent building laws calling for the use of steel for this purpose have produced a demand for a steel guide that shall fulfill the

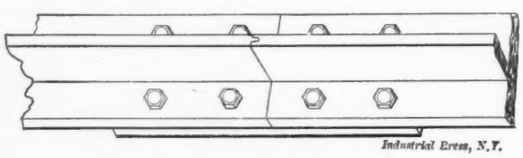


Fig. 4. Compressed Steel Elevator Guide.

requirements with satisfaction. The production of such guides by the ordinary machining methods is one of considerable difficulty since they require to be perfectly straight and of sufficient length to avoid too numerous joints. These conditions are such as to make the steel compression process admirably fitted to their production. The sketch illustrates a guide that is now being made, of open hearth steel, by this process and which can be produced in lengths up to 19 feet. This method of finish gives a uniform size throughout the entire run and produces a smooth, hard running surface that is easy to clean and greatly reduces the friction of the car.

The matter of the joint has received especial attention as it is usually at this point that trouble with the ordinary guides is likely to ensue. To make a smooth and rigid joint, in the lower ends of each length is milled a groove which is fitted to receive a corresponding tongue cut on the upper end of each length. The lengths are then matched, as shown in the cut, so that the tongue insures rigidity and prevents any possibility of one end bending over or slipping by the other thus breaking the joint. The ends are held together longitudinally by means of fishplates bolted on the back side and as the rails and plates are all drilled to standards the erection of the guides is greatly facilitated. They are made by the Standard Gauge Steel Co., Beaver Falls, Pa.

THE USE OF PERMANENT MOLDS.

In a paper on permanent molds read by James A. Murphy before the American Foundrymen's Association at Milwaukee, Wis., June 9-11, it was stated that loam molding has reached a high degree of perfection in this country, and that more and more attention is being given to the saving as much as possible of each mold in order to reduce the cost of the castings made. In other words the permanent mold is the object sought. Large kettles, pans, domes, pipes, etc., are classes of a type of work that can be made cheapest in permanent loam molds. The paper illustrates a mold for a kettle weighing fourteen tons that will last for several years' continual use, turning out a kettle every few days. The core is swept up and is

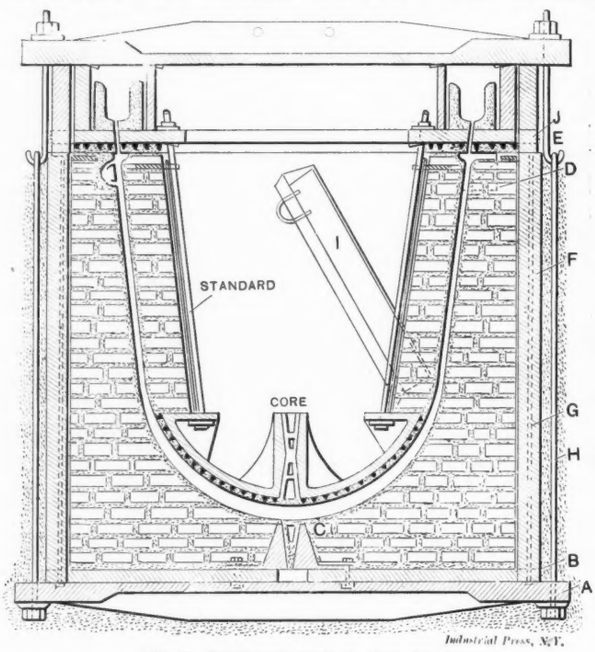


Fig. 5. Permanent Mold for Iron Kettle.

preferably dried in an oven. A pit is dug in the floor in some convenient location and the binders *A* and the bottom plate *B* are set in place; and the spindle step *C* for the mold sweep by which the interior of mold is swept up. The brickwork is laid so as to allow a thickness of from ½ to ¾-inch of loam. If the bricks are not of good quality, it is best to use firebrick for the face. Upon the top of the wall is placed a strong cast iron ring *E*, which is recessed to clear the eight iron frames *D*. These latter are for the reception of cores for handles, brackets or other projections, and can be removed without disturbing the wall. Other details as explained in the paper are such as to avoid the disturbance of the brickwork when a casting is stripped. As a whole this paper should be of much interest to foundrymen.

SOCKET WRENCH WITH ADJUSTABLE STEM.

In the average machine shop a set of socket wrenches ordinarily represents a somewhat expensive equipment that is rarely used, but the need of which is so urgent when they are wanted that they must be kept at hand. For the usual run of work the socket wrench cannot be conveniently employed so it is relegated almost entirely to the special work for which it is designed. But by jointing the stem *B*, Fig. 6, where it

joins the socket *A*, the usefulness of this class of tools is greatly increased, as they may then be used for their designed purpose and for work that the ordinary socket wrench cannot handle. For example, by loosening the binding screw *C*, which is ordinarily set up tightly, the stem is free to move on a pivot, and then a nut or screw can be turned when located under a ledge, the connection acting as a sort of universal joint. The stem, in such cases, assumes an angular position, say, *B'* in the lower view. Again by locking the binding

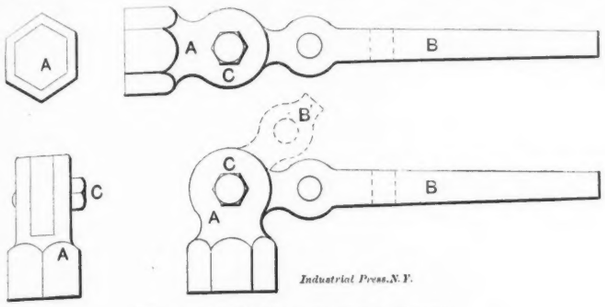


Fig. 6. Adjustable Stem Socket Wrench.

screw with the stem *B* in a right angle position, we have a fairly good substitute for the "box" wrench, especially if the stem or handle is made somewhat longer proportionally than indicated in the cut. But perhaps the most valuable feature possible in this combination is that the sockets and stems can be made interchangeable, thus making it possible for one set of each to cover all probable requirements.

COMPARATIVE EFFICIENCIES OF STEAM PUMPS AND STEAM TRAPS.

In the catalogue of the American Blower Co., Detroit, Mich., which deals with the Morehead steam traps of their manufacture, is given a comparison of the efficiencies of steam pumps and steam traps for returning water of condensation to the boiler, from which we quote. These traps operate on the gravity principle, have steel tanks and will return the condensation from either above or below the water line of the boiler.

A pump will not lift water at a temperature exceeding 212 degrees; a return trap will. A pump consumes an extravagant amount of steam to do very little work. For example, an ordinary duplex boiler-feed pump requires from 90 to 120 pounds of steam per horse-power hour. A common slide valve engine seldom consumes less than 40 pounds per horse power. A return trap consumes less than 10 pounds per horse power. The pressure is admitted to the surface of the water, and is automatically shut off before the tank is empty. The steam used is only such as is condensed by the latent heat passing from it into the water in the tank, which is all put back into the boiler.

A return trap requires no attention further than to repack the gland, perhaps once a year, and to tighten same about every three months. It requires no cylinder lubrication; will not race or run away; never sticks; is noiseless; requires little room and no foundation; in fact, a pump has no feature in which a return trap is not superior.

Assume the steam pressure carried is 100 pounds, and all condensation is cooled to the temperature of the feed water, is passed through a feed-water heater, and is then pumped into the boiler by a boiler feed-pump at a temperature of 200 deg. The total heat in water raised from 32 deg. to 200 deg. is 168.75 B. T. U. The heat in steam at 100 pounds pressure is 1,185 B. T. U. Thus, to raise one pound of water from 200 deg. to 100 pounds pressure has required the addition of 1016.25 B. T. U.

Supposing, again, the condensation is returned to the boiler by a return steam trap instead of a pump. With a return trap the condensation will not be cooled below the temperature of the steam at which it is condensed, which in this case is 337.8 deg. The heat in water at this temperature is 309.5 B. T. U. Therefore, to evaporate the water into steam at 100 pounds pressure will require 875.5 B. T. U. Thus the saving is the difference between 1,016.25 and 875.5, amounting to 140.75 B. T. U. per pound of water, or nearly 14 per cent.

This does not take into account any losses by radiation, leakage, etc., but these would apply to either a pump or a trap, and owing to the greater amount of steam required to operate a pump, as already shown, the net gain would be considerably more. If the temperature of the feed water was only 100 deg. instead of 200 deg., as above assumed, a return steam trap would show a net gain of more than 20 per cent.

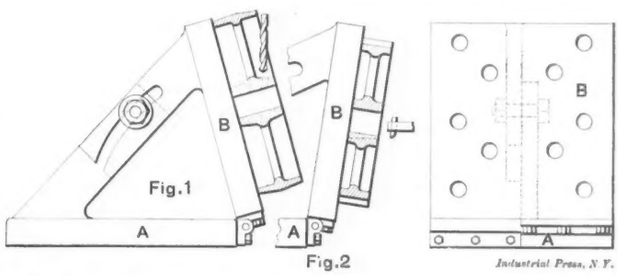
Apply the above to a plant of 200 horse power, having an efficiency of 65 per cent. and an evaporative capacity of 6,900 pounds of water per hour from and at 212 deg. Burning coal containing 13,000 H. U., one pound should evaporate about 8.3 pounds of water from 200 deg. and 9.65 pounds when returned to the boiler at 337.8 deg. To evaporate 6,900 pounds of water per hour from and at 212 deg. Burning of coal per hour, the latter representing a saving of 115 pounds of coal per hour. This saving on a day's run of ten hours for 200 days—this being about the heating period for a year—will amount to 115 tons. At $2.50 per ton, it will amount to $287.00, more than twice the cost of installing a trap large enough to handle a plant of this size.

* * *

CONTRIBUTED NOTES AND SHOP KINKS.

AN ADJUSTABLE ANGLE PLATE.

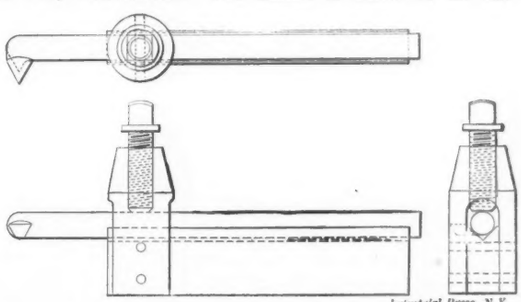
The sketch of the adjustable angle plate, contributed by A. McA., shows a shop appliance that will be found very handy in a large number of cases for use on planer, shaper or drill. For shaping any work at given angles, planing taper keyways, drilling oil holes in pulleys, or any work of this nature the fixture is readily adapted. It consists of a base *A* to which is hinged the face *B*, drilled with numerous holes for fastening



on the work. A back rib on the base carries a clamping bolt which runs through a slot in a corresponding rib on the back of the face piece, and by which the two are clamped together when they have been set at the required angle. The sketch shows the plate set for drilling oil holes in pulleys and also, in Fig. 2, how it is arranged on the planer for planing taper keyways.

A DEEP BORING AND THREADING TOOL.

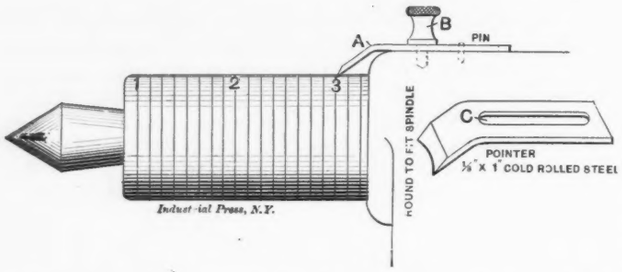
It often happens that a job comes up requiring a comparatively long and small hole to be bored and perhaps threaded, for which purpose it is customary to have the blacksmith draw out a special tool. To save this trouble such a tool as is shown in the sketch, sent us by E. H. R., will be found very convenient. The shank is made to fit the tool-



post of the lathe while the cutter may be set out to any length and firmly clamped by tightening up the setscrew. Since the cutter is independent of the shank the height of the cutting point can be easily raised or lowered by simply turning the cutter bar before it is tightened up. This tool is especially handy for use on odd-sized holes and special threads for which reamers and taps are not provided.

GRADUATIONS ON THE TAILSTOCK SPINDLE.

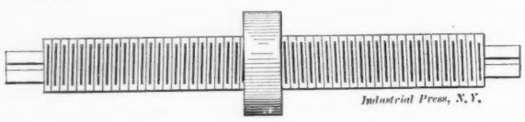
R. A. L. sends a "kink" regarding an improvement for the lathe tailstock which, he thinks, might well be adopted by the lathe builders. In order to drill holes to a required depth, in work held in the lathe chuck, some sort of a mark must be made on the drill or measurements taken on the tailstock. Marking the drill is rather unhandy on account of its being hardened, so the scheme of graduating the tailstock spindle will be found much more convenient.



To prepare the tailstock for this arrangement, the spindle is taken out and put on the centers of a lathe which is geared for cutting eight threads per inch. A sharp pointed V-tool, placed in the toolpost, is used as a scriber and the spindle is rotated by hand until a sufficiently clear circle is cut upon it. The cone of the lathe is then given one complete turn, thereby moving the tool ⅛ inch, and the next circle is scribed in a similar manner to the first. This is continued until the spindle has been graduated for its entire length. Beginning with 1, the even inches are now stamped with their respective numbers and the spindle is replaced in the tailstock. The pointer *A* is clamped to the top of the tailstock by the thumbscrew *B* and a slot *C* allows the pointer to be moved backward and forward when the screw is loosened. In drilling a hole, as soon as the full diameter of the drill enters the work the pointer is adjusted to the nearest even inch mark and clamped. The depth to which the drill is fed is then read directly from the graduations on the spindle.

A SHOP APPLICATION OF ELECTRIC WELDING.

A. D. K. writes: Some time ago it became necessary to repair twelve chuck screws such as are shown in the accompanying sketch. They were ⅝ inch in diameter with heads squared down to the bottom of the threads. These heads had worn round on the corners and in some cases they were twisted nearly off while the threaded portion of the screws were as good as ever.



To repair them I cut the old heads off within ⅛ or 3-16 inch of the threads; then short pieces of tool steel, large enough to form the square of the heads, were welded on in the electric welding machine. The heads were then squared up and hardened and the screws were as good as new, the entire time consumed in making the repair being only about one hour.

A KINK IN DIVISION.

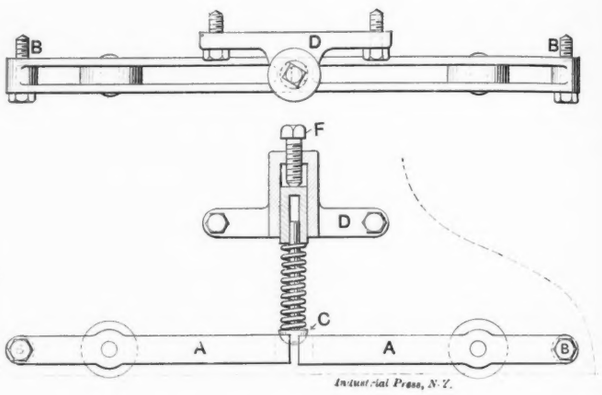
Clay-Beau sends a "kink" for dividing fractions regarding which he writes: By the machinist and apprentice no arithmetical operation is more frequently encountered than the division of inches and fractions thereof by two, as in laying off center lines, spacing, etc. While the division of an even number and a fraction by two is easy enough to almost any one, it is surprising to note how much "fussing" is done by many over the division of an odd number and a fraction. My attention was recently called to the following method which, although it may not be new to all of the readers of MACHINERY, will, I am sure, prove very convenient to those who have never used it.

To divide an odd number and a fraction by two, write the expression in the ordinary manner, draw a line beneath it and add together the numerator and denominator of the fraction, placing the sum in position for the numerator of the fraction of the quotient. For the denominator of this fraction multiply the denominator of the fraction which is being divided, by two. Deduct one from the whole number of the expression that is being divided and divide the remainder by two. The following examples will show clearly how the method is operated.

$$\frac{31\frac{31}{32}}{15\frac{63}{64}}; \quad \frac{1\frac{1}{32}}{\frac{33}{64}}; \quad \frac{7\frac{19}{25}}{3\frac{52}{50}}; \quad \frac{19\frac{57}{141}}{9\frac{198}{282}}$$

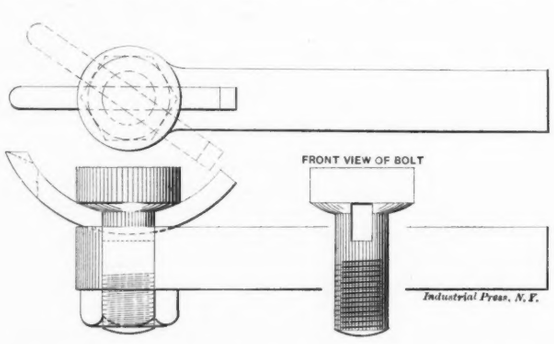
A TAILSTOCK TRUCK.

"Student" sends us a sketch of an attachment which he uses on heavy tailstocks to facilitate sliding them along the bed of the lathe. On either side of the tailstock is fastened the frame *A A*, by means of the tap bolts *B B*, and two rollers are mounted on journals near the ends of each frame. The frames are cut in two in the center and the plunger *C* fits into a socket, part of which is formed in each half of the frame. A bracket *D* is fastened to the side of the tailstock, above each frame, and the pressure of the spring is so adjusted by means of the setscrew *F* that the weight of the tailstock is supported on the rollers. It is clamped to the bed in the usual manner, but as soon as the clamps are released, preparatory to moving the tailstock, the force of the spring raises it at once onto the rollers so that it may be easily slid to any place on the bed that is desired.



A HOLDER FOR USING CURVED TOOLS.

E. J. B. sends a sketch of a novel holder for inserted tools, to be used on lathe, planer or shaper, which, he says, is giving better success than anything he has ever used before. The tool is curved to a radius of three or four inches and the boss on the shank is turned out to fit the outside or bottom curve of the tool, while the clamping bolt fits the top radius. As will be seen by the sketch, by pushing the tool forward or backward any desired rake can be obtained, while the blade may also be swiveled at any angle for right or left hand use, as indicated by the dotted view. For holders to take ¾ or ½-inch self hardening tool steel the bolt head and boss on the holder should be about 1¾ inches in diameter.



HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

30. F. H.: How are the various dimensions of the teeth of the large gear made by the Bethlehem Steel Co., as mentioned in the June issue, figured? What is the outside diameter and does 6⅛-inch pitch mean circular pitch?

A. The pitch diameter is 20 feet 9.55 inches, or more exactly, 20 feet 9.554 inches. Expressed in inches the pitch diameter is 249.554 inches, and multiplied by 3.1416 it equals 784 inches pitch circumference nearly. Dividing 784 by 128 teeth gives the circular pitch, or 6⅛ inches. To change this to diametral pitch, divide by 3.1416 or multiply by 0.3183. Dividing 6.125 by 3.1416 (or multiplying by 0.3183) equals 1.95 nearly, which is the module for 6.125 inch pitch, or 1.95 inches diametral pitch. Since it is the general practice to make the addendum face equal to the diametral pitch, it is only necessary to multiply the diametral pitch, 1.95 inches, by 2 and add the result to 249.554 in order to get the outside or addendum diameter. $249.554 + (1.95 \times 2) = 253.45 +$ inches outside diameter.

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31. W. C. W.: Can aluminum be cast in steel molds and produce smooth accurate castings that will require no finishing?

A. The Pittsburg Reduction Company inform us that aluminum can be successfully cast in metal molds provided they are heated quite hot before pouring the metal. Better work can be produced this way than in sand molds. Aluminum melts at a temperature of about 1,250 degs. Fahr., and shrinks in the mold somewhat more than cast iron and less than brass. The heating of the mold partially compensates for the shrinkage so that the cavity need not be made the full shrinkage allowance larger. The principal reason for heating the mold, however, is to prevent injury to the piece, which would otherwise be likely to occur on account of the unyielding nature of metal molds as compared to sand. The degree of accuracy that you require will determine whether the castings produced in this way will meet your requirements. The H. H. Franklin Mfg. Co., Syracuse, N. Y., make metal castings (not aluminum) in metal molds, absolutely true to gage and these are being largely used in the manufacture of cash registers and other apparatus needing a large number of duplicate parts difficult to machine and which must be true to gage.

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32. N. A. S.—Will you kindly give me information regarding the thickness of metal for common valves, such as globe valves, etc.? For metal I wish to use a composition of copper, 88 per cent., tin 10 per cent., zinc 2 per cent. 2.—How thick should a globe valve be, 8 inches diameter, to be used under a head of water of 14 feet?

A.—The rules used by manufacturers of valves are purely empirical. If the thickness of the walls were calculated by the ordinary formula for the strength of a cylinder, it would be amply strong to stand the pressure, because a valve is more or less spherical in shape, and is reinforced by flanges, webs, etc. But a valve would actually be made heavier than this, because it is so irregular in its form that the strains incident to cooling in the mold might crack or at least weaken it. Just how much to allow for this is a matter for the designer to decide. In the data sheet with the Engineering Edition of MACHINERY for October, 1902, was published some information with regard to the practice of the Crane Company in valve design. For 6-inch pipe they use thicknesses of ½ inch, 9-16 inch, and ¾ inch for light, medium and heavy valves, respectively; for 12-inch pipe, ½, 13-16, and 1 inch; and for 24-inch pipe, ¾, 1¼, and 1½ inch respectively. Your composition will probably be about 25 per cent. stronger than cast iron, and you will be safe in assuming a tensile breaking strength of 20,000 pounds per square inch. The rule for thickness of pipe above mentioned is: Multiply pressure in pounds per square inch by diameter in inches, and divide this result by twice the tensile strength. Allow a factor of safety of six. 2.—Your valve, to withstand a head of water of only 14 feet, can be made light as can be cast in the foundry, say ⅜ or ½ inch thick.

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33. M. P. C.—What are the best rates of flow for water, air and steam through pipes? There must be some happy medium in the items of cost, length, friction, etc., for pipes of ordinary length. What I want is three figures, one each for water, air, and steam, which shall express the best or customary speeds for each of these.

A.—It is common to proportion the delivery pipes of pumps so that the flow shall not be over 400 feet a minute—preferably less. The old and reliable figure for steam pipes is 6,000 feet per minute. In air transmission, the carrying pipes are usually much smaller than steam pipes used for steam engines, etc., and the distances of transmission are generally much greater than with steam, so that 1,200 feet may be taken as a maximum figure. We do not consider, however, that any figures could be given that would answer your question properly. The loss from friction in transmission depends upon so many different elements, such as diameter and length of pipe, number of elbows and valves, velocity, pressure, etc., that no judgment should be rendered in any particular case until a calculation had been made, using the best available data at hand. Calculations for flow of water can be made with considerable certainty of result, and very clear directions are given for these in Merriman's Hydraulics, published by Wiley & Sons, New York. For the flow of steam the following formula may be used, based on experiments by Prof. Carpenter of Cornell:

$$p = \frac{w^2 l \left(1 + \frac{3.6}{d}\right)}{7500\, D\, d^2}$$

$p =$ fall of pressure in pounds per square inch.
$w =$ pounds steam discharged per minute.
$l =$ length of pipe in feet.
$d =$ diameter of pipe in inches.
$D =$ weight cubic foot steam at the lower pressure.

For the flow of air we will refer you to Kent's pocketbook; also to catalogues of air compressors.

Question No. 28 answered by C. E. Coolidge, Ithaca, N. Y.

The contributor of question No. 28 asks for a simple method for determining the pitch diameters of sprocket wheels when the chain block, side links and number of teeth are the known factors. I take the liberty of submitting the following graphical method which, I believe, is far more satisfactory than the long computations involved in the formulas given in Brown & Sharpe's catalogue:

Suppose in Fig. 1 a design of the tooth, chain block and side links of a segment of the sprocket are shown laid off on a straight line either on paper, wood or metal. Then, knowing the number of teeth and the fact that the center lines of

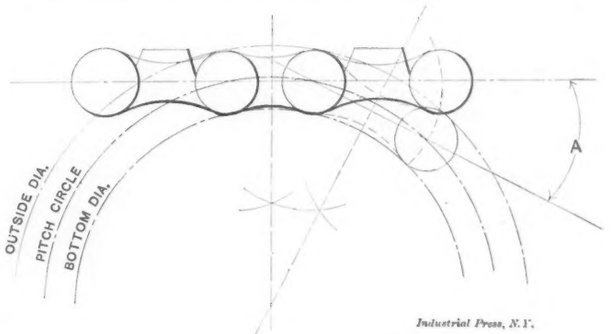


Fig. 1. Laying Out Sprocket Wheel.

the links and blocks make equal angles when laid off as chords on the pitch circle, it is evident that the angle, A, is known from the well known proposition in geometry that the sum of the exterior angles of a polygon are equal to four right angles. Hence, if n represents the number of chords made by the center lines of links and blocks then the angle $A = \frac{4 \times 90.}{n}$

The value of the angle *A* can be taken from the accompanying table which gives the different values of the angle corresponding to the number of teeth on the sprocket. These angles are shown in Fig. 2, each marked with the corresponding

TABLE OF EXTERIOR POLYGONAL ANGLES.

Number of Teeth.	Angle A.	Number of Teeth.	Angle A.
6	30.	18	10.
7	25.71	19	9.47
8	22.50	20	9.
9	20.	21	8.57
10	18.	22	8 18
11	16 36	23	7.83
12	15.	24	7.5
13	13.84	25	7.2
14	12.86	26	6.93
15	12.	27	6.67
16	11.25	28	6.43
17	10.59	29	6.21
		30	6.

number of teeth and they can be laid off in Fig. 1 by transferring, without the use of the protractor or other construction.

Having laid off angle *A*, the center of the pitch circle which passes through the vertices of the angles formed by the chords is found by the usual geometrical construction which consists in locating the point of intersection made by the intersection of the perpendiculars to the middle points of the chords. The bottom and outside circles of the sprocket wheel are drawn tangent to the arcs bounding the ends of the block.

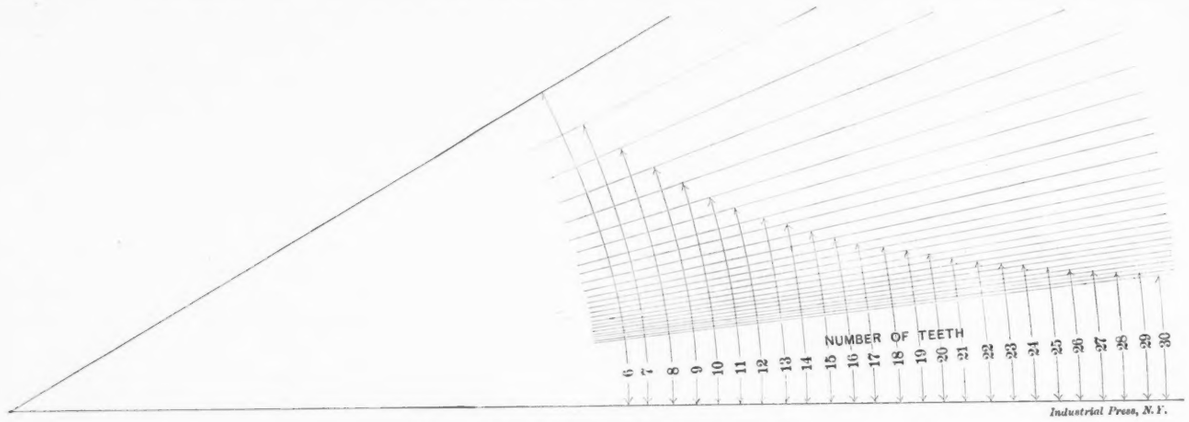


Fig. 2. Angles for Laying Out Sprocket Wheels.

* * *

MAKING CYLINDER HEAD COVERS ON A STEAM HAMMER.

The general practice in railway shops relative to cylinder head coverings is now to make them of pressed steel instead of cast-iron as formerly prevailed. The pressed steel casings are not only much neater in appearance, but much more durable, as it is practically impossible to break them and even if badly bent they can usually be straightened out so as to fulfill their function satisfactorily. The ordinary process of making pressed steel work of this description requires a hydraulic press, a machine that is rarely found in the average railway repair shop. But the Lehigh Valley R.R. shops at Easton, Pa., impressed a double-column steam hammer into this class of work with very good results and at an expense for special equipment, quite trifling. Cast-iron male and female dies are provided for the different sizes required, and these are made with a dovetail on the back to fit the hammer and anvil, as at *A* and *B*, Fig. 1. A hole is first drilled or punched in the sheet designed for the casing and then it is trimmed to circular shape, on a circular slitting shear. After being heated in an oil furnace the disks are laid on the female die with the vertical pin *E* projecting through the hole in the center. A hole is provided in the die *A* so that the pin is not disturbed when the blows are struck.

In these shops, and presumably in others of the same system, it is the practice to fit driving wheel axle keys on the sides only. The keyway is located, as shown at *D* in Fig. 2, and not at *D'* as is the usual practice. We believe the practice followed by the Lehigh Valley R.R. people in the location of this keyway is based on sound principles. It is better to place the keyway where the metal is under the least initial

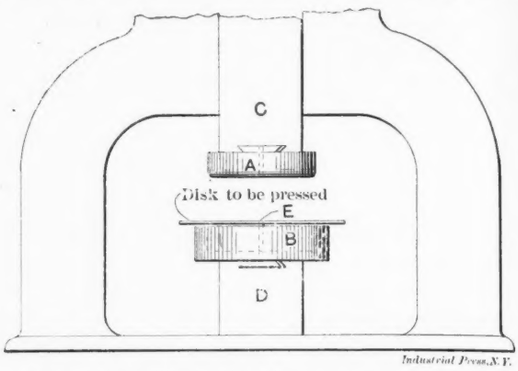


Fig. 1. Making Cylinder Head Cover on a Steam Hammer.

stress and that is undoubtedly on the side of the axle *A*, opposite the crankpin *B*. Nine-tenths of the wheel centers that crack in service having the keyway located between the axle and the crankpin, will be found to have the crack radiating from one corner of the keyway to the crankpin hole. With the keyway oppositely located the metal is not removed from the spot where it is most needed. As already stated, the keys are fitted sideways, no attempt being made to have them fill top and bottom. In fact the reverse is the case, clearance to the extent of about 1-32 inch always being allowed. The keys are fitted by the planer hand, no hand fitting by filing being done. This, of course, does away with the time-honored prac-

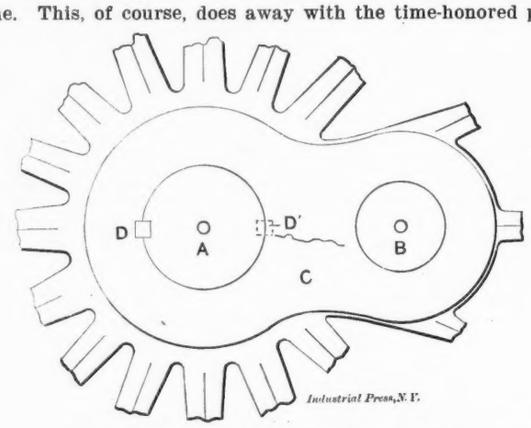


Fig. 2. Correct and Incorrect Location of Keyway.

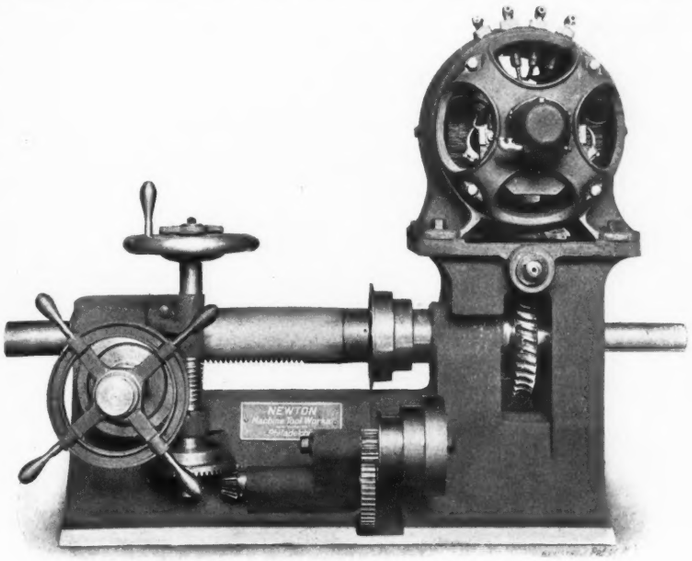
tice of having a key forged on the end of a heavy bar with an overhanging head. The number of times a key, fitted in this manner, will be driven in and hammered out by striking under the head depends on the patience of the fitter and his idea of how much time he should put on the job. The machine-fitted key is much better in every way and of course considerably cheaper in cost.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

PORTABLE HORIZONTAL DRILLING MACHINE.

The accompanying illustration shows a new design of portable, horizontal drilling machine which is the outgrowth of the demand for portable tools to be used on a floorplate in accordance with modern shop methods. It can be used to advantage by engine builders, manufacturers of electrical machinery, etc. The machine shown is the smallest of several sizes which are adapted to meet the different requirements of the work to be handled.



Portable Horizontal Drilling Machine.

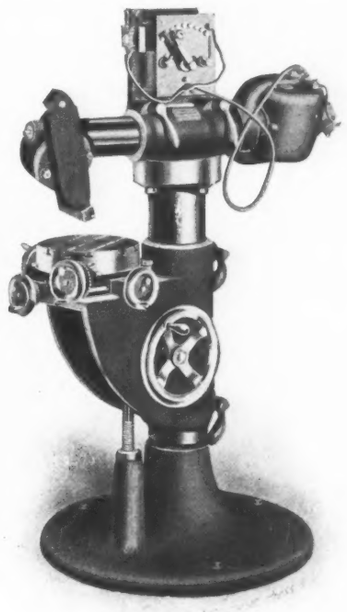
The machine is very powerful, being geared from the armature shaft to the worm shaft, and power being supplied to the spindle by means of a steep lead, phosphor bronze, worm wheel driven by a hardened steel worm. There are three changes of automatic feed, hand feed and quick return. The base is planed on the bottom edge, parallel with the spindle, for convenience in setting on the floorplate, or for parallel strips as required. These machines are made by The Newton Machine Tool Works, Philadelphia, Pa.

A UNIVERSAL SHAPER FOR PUNCH AND DIE WORK.

The shaper illustrated in the photograph herewith is built upon entirely new and original lines and is designed for all kinds of intricate punch and die work as well as for metal pattern and jig making. It justifies its claim as a universal machine by its ability to work at every possible angle. The tool cuts from the face of the work leaving no burr to cover the lines, making it possible to machine very accurately so that little if any hand work is required. The working head is carried upon a horizontal arm which is supported by the head of the column and this is graduated so that it may be clamped at any position about the column. This arm has also an in-and-out adjustment that allows the head to be brought to any position above the table.

The head may be adjusted at any angle about its axis, which is at right angles to the arm, and as the arm in turn may be adjusted to any position about its own axis, it is therefore possible for the head to work at any angle desired. Graduations are provided for both of these adjustments. The ram is driven by a worm and wormwheel, direct connected to a motor that is mounted at the end of the arm, and the stroke of the ram is adjustable.

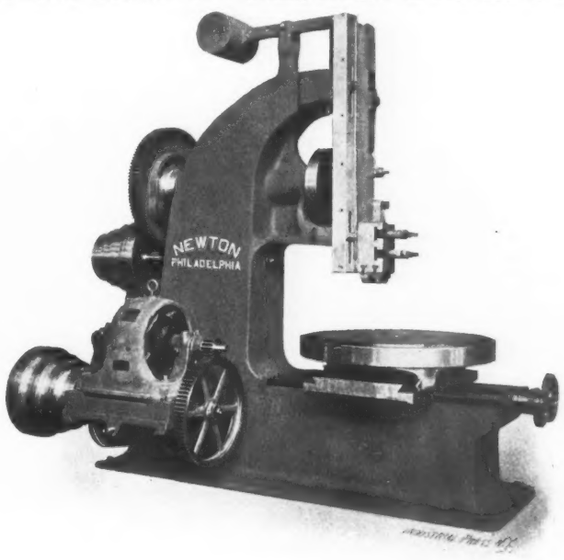
The table has circular and two cross movements, the handwheels by which it is operated being provided with dials for micrometer readings and the table itself being graduated. Provision is made for locking the circular movement in any position or for disengaging it so that the table may be swung around freely. The circular movement is obtained by means of a worm and wormwheel having the same ratio that is used in universal dividing heads and thus fitting it for accurately indexing dies for small gears, armature plates, etc. The machine is made by the Cochrane-Bly Machine Works, Rochester, N. Y.



Universal Punch and Die Shaper.

ELECTRICALLY-DRIVEN SLOTTERS.

The Newton Machine Tool Works, Philadelphia, Pa., have just brought out a new line of slotting machines, built from new designs, and arranged for electric motor drive. The illustration shows the 14-inch machine using the regular driving cone pulley as would be used with a belt-driven tool, with the motor mounted on a sliding bracket on the side of the machine, and gearing from the armature shaft to the cone shaft, which acts practically as a countershaft, giving the desired changes of speed.



Motor-driven Slotter.

The same machines are also arranged with a positive drive by gearing the armature shaft directly to the operating gears, the variation of speed being obtained through slip gears, the same as change gears on a lathe. The same design is also used, with the slip gears omitted, when variable speed motors are employed.

HEAVY DOUBLE-SPINDLE BORING MACHINE.

The large double-spindle boring machine shown in Fig. 1 was recently built by the Betts Machine Co., Wilmington, Del., and installed by the Philadelphia & Reading Coal and Iron Co. in their shops at Pottsville, Pa. While primarily intended for boring the cylinders of Corliss engines, machining the ports and cylinders simultaneously, it is a machine that can be advantageously used on a wide variety of heavy work for boring and milling. The work spindles are located at right angles, and are independently driven through geared variable-speed mechanisms by five horse power induction motors running at a constant speed of 710 revolutions per minute. The machine is practically two independent horizontal boring mills mounted at right angles and using a common floor plate. The main floor plate is a rectangular casting, 10 feet wide by 17 feet long. Bolted to one side and across one end are the castings supporting the heavy posts carrying the boring heads. These plates are 40 inches wide and about 20 feet 8 inches long, being extended so as to form the supports for the motors and reduction gearing. One end of the main floor plate is used for the outboard bearing of one boring bar, and an extension plate 34 inches wide and 14 feet 10 inches long is bolted to the side of the main bedplate opposite the other boring head to support its outboard bearing. With the outboard bearings or steady rests removed, an unobstructed floor plate nearly 13 feet wide and 17 feet long is available.

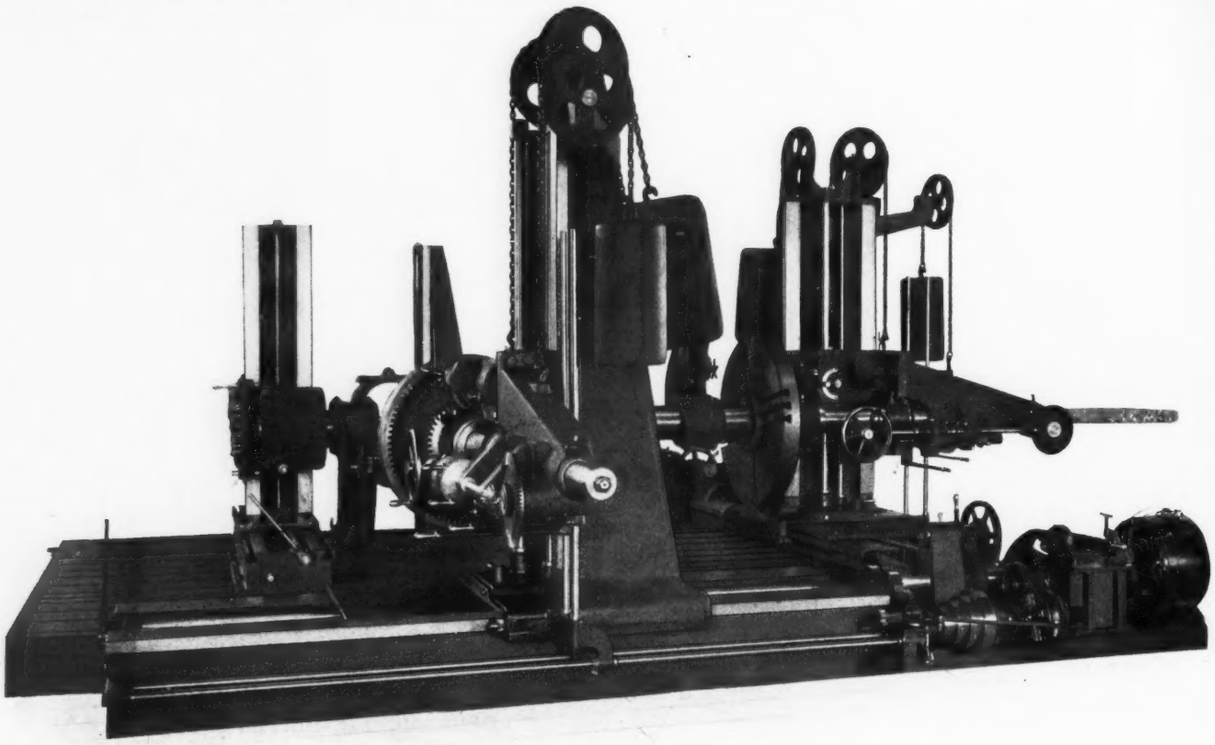


Fig. 1. Betts Double-spindle Boring Mill.

The work spindles are 4 15-16 inches diameter and have a traverse of 48 inches. When boring large cylinders a cast-iron bar 10 inches in diameter is used, which is bolted to the faceplates and supported at its outer end by the outboard bearing. The traversing boring head on the bar is operated by a star feed, and the two facing heads on the bar are fed in the same manner. The posts carrying the boring heads are traversed on the bedplate by screws, the traverse being 10 feet in each case. The vertical height of the posts is 7 feet 9¾ inches, and the vertical traverse is 54 inches. The speed and direction of vertical and horizontal traverse is controlled by the operator, through the medium of the handles shown be-

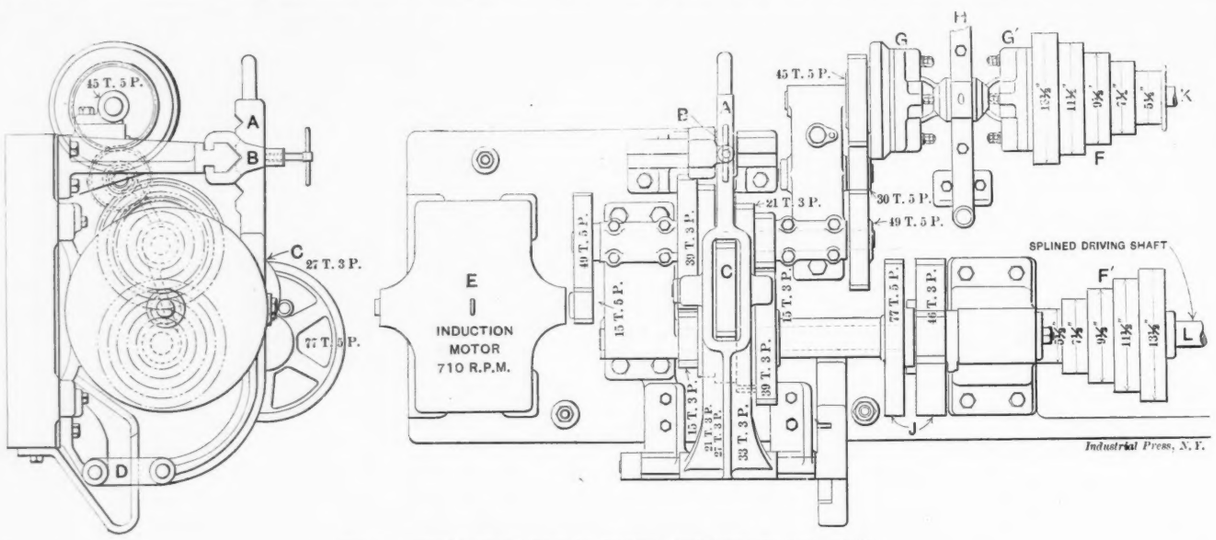


Fig. 2. Variable Speed Gear for Driving Double-spindle Boring Mill.

neath the boring head in the foreground; also at the right of Fig. 1.

The positive variable-speed gear is shown in Fig. 2. It consists of two cones of gears between which is the transmitting pinion *C*, mounted on the frame *A*. This frame may be moved longitudinally so as to bring the transmitting pinion *C* between any pair of gears in the two cones. The link *D* permits the frame to shift transversely so as to accommodate pinion *C* to the relative positions of the gears brought into engagement. Notches on the frame *A* engage the V-shaped top of the slide upon which it normally rests and a clamp is provided for locking it in place. The cones of gears in conjunction with the back gears *J* give ten changes of speed up to the boring head. Motion is transmitted to the work spindle by means of a pinion which may either engage the internally toothed faceplate or a smaller gear on its hub, thus multiplying the speed changes by two, so that spindle has twenty different speeds. The slow traverse of the saddles carrying the spindles horizontally and vertically, as necessary for milling operations, is taken from cone pulley *F'* by belt to cone pulley *F* with the clutch lever *H*, Fig. 2, at the right. The cone pulley *F* then drives the shaft on which it is mounted. For the fast traverse the clutch *H* is shifted to the left, engaging clutch *G*, which has the effect of driving the shaft *K* at one-third the rate of the motor, and, of course, giving a relatively rapid traverse. Tumbling gears are interposed between the shaft *K* and the traversing screw, so that the motion may be reversed. Reversal is effected by means of the horizontal and vertical splined shafts, and the levers beneath the boring head previously referred to. Split nuts are provided in the bases of the posts, so that engagement with the horizontal screw may be thrown out when vertical traverse is wanted. To throw out the vertical traverse the bevel gears transmitting motion to the vertical screws are disengaged. Since the direction of spindle rotation would be changed when shifting the driving pinion from the internally toothed faceplate to the external gear previously mentioned, it is necessary to provide means for again reversing the direction of rotation to prevent running backward. This is done by shifting a pair of bevel gears vertically on the vertical splined driving shaft, so that one disengages as the other engages. This is also used when tapping. The lever for doing this shows plainly in Fig. 1, on the right-hand boring head directly over the spindle and at the left of the feed handwheel.

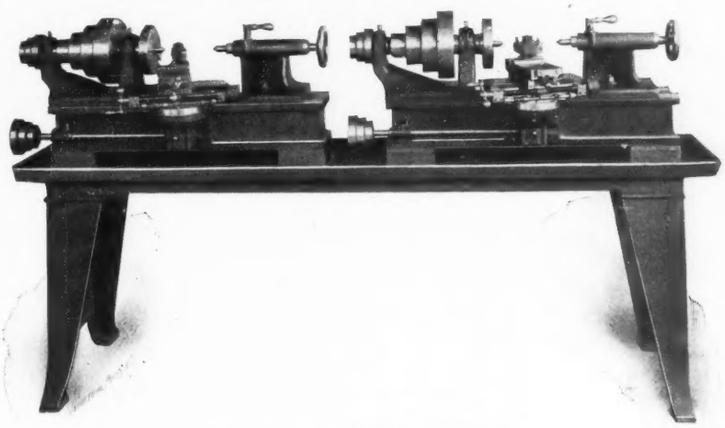


Fig. 1. Duplex Universal Turning Lathe.

It will be noticed that the boring heads are counterbalanced at three points, the object being to avoid all canting, twisting moments as much as possible. The weight of the machine complete is 105,000 pounds.

TWELVE-INCH UNIVERSAL TURNING LATHE.

The duplex lathe illustrated in the accompanying half-tone was designed for turning all kinds of work requiring accuracy and at the same time speed of production. It is built with two bodies mounted upon one rigid base which forms a pan for catching the chips and oil. The tool saddle is rigidly fastened to a lug that is cast on one side of the bed and may be swiveled to any angle required. Feed motion is transmitted from the feed rod, through gearing, to the slide rest which is provided with automatic feed in either direction irrespective of the position to which the slide may be turned. Adjustable feed stops are also provided. The gearing is all encased and protected from chips and dirt.

The tool holder furnished on these lathes, and shown in section in Fig. 2, is of new design and fitted for carrying a tool of self-hardening steel at each end. The lower bushing is threaded into the body of the holder so that by turning the bushing the holder may be raised or lowered to any desired height where it is locked by the nut on the top. By releasing this nut the tool may be used at either end. This lathe and tool holder are built by the Resek Machine Tool Co., Cleveland, Ohio.

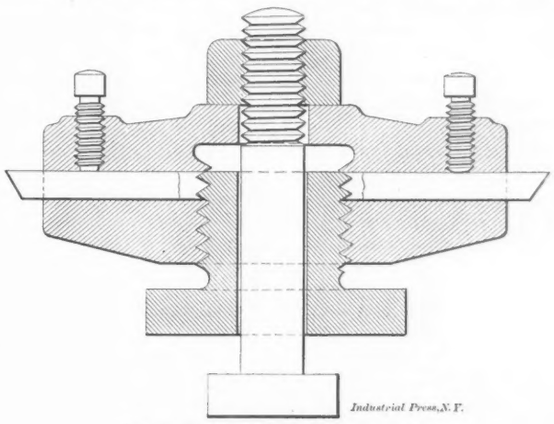
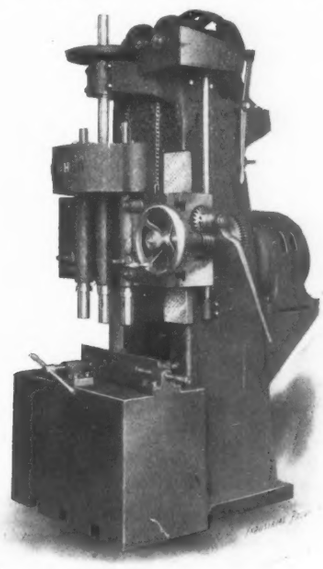


Fig. 2. Double Adjustable Tool Holder.

A THREE-SPINDLE RAILROAD FISH-PLATE DRILL.

The accompanying half-tone illustrates a three-spindle drill that is designed especially for drilling the ends of rails and for fish-plates. The machine has a capacity for drilling, simultaneously, three 1½-inch holes in steel. The spindles may be set to drill holes spaced at any center distance from 3¼ up to 9½ inches. The two outer spindles have a vertical adjustment, by rack and pinion, of 3½ inches and can be clamped in any position required. The spindles are bored out for No. 4 Morse taper and, on account of the spindle adjustment, taper shank drills can be used, thus doing away with the objectionable method of using setscrews for the adjustment of straight shank drills.



Rail and Fish-Plate Drill.

The three spindles are carried on one saddle, which is counterbalanced and feeds the three simultaneously. The center spindle is driven by a large bevel gear on top of the column, and this in turn drives the two outer spindles by

spur gearing, through intermediate gears that are pivoted to both the central and outer spindles and move in and out with the horizontal movement of the spindles. The saddle carrying the spindles has three changes of power feed and quick return. The feed is driven by cones of gears and changes in feed are quickly made by a lever on the side of the column. The work table is provided with an adjustable vise for holding the rails and both right and left hand stops for the end of the rail can be used.

The cuttings drop through an opening in the top of the table and thence, through another opening in the back of the column, out of the way of the operator. There is also an opening, 10 inches square, through the back of the column on a level with the top of the table, allowing work to be put through the column, to be operated upon. The photograph shows the machine arranged for motor-drive, but it is also furnished for belt driving by the builders, the Mark Flather Planer Co., Nashua, N. H.

GLEASON IMPROVED CUTTER GRINDER.

The F. Gleason Machine Works, Olney, Pa., have brought out an improved form of cutter grinder which is illustrated herewith. In this machine the spindle carrying the wheel is so mounted that it can be swung from the vertical position, in which it is shown, through any angle down to the horizontal. This brings the wheel within range of a great variety of work and allows wheels of different shapes to be used. The spindle has a movement, through a quill and handwheel, of 3 inches, the hub of the handwheel being graduated to .002 inch. The head in which the spindle is carried has a horizontal adjustment of 3 inches and may be locked, by means of a lever, in any position.

The pawl guide by which the teeth are fed around, can be changed from a level to an angular position and may also be raised or lowered in its socket to suit the requirements of the cutter. For instance, in grinding a spiral cutter any tooth which is most convenient can be acted upon by the pawl as it can be fed from either side as well as from the top. Cutters, up to 3 inches in diameter are held by friction between the centers but for the larger sizes a carrier is used in the faceplate *F* which is attached to a sleeve that passes through the split collar *G* and is locked by the setscrew *H*. This lock is always employed when grinding large cutters with the exception of spirals.

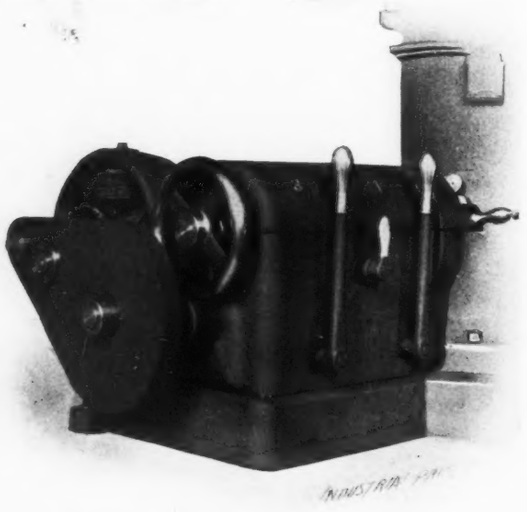
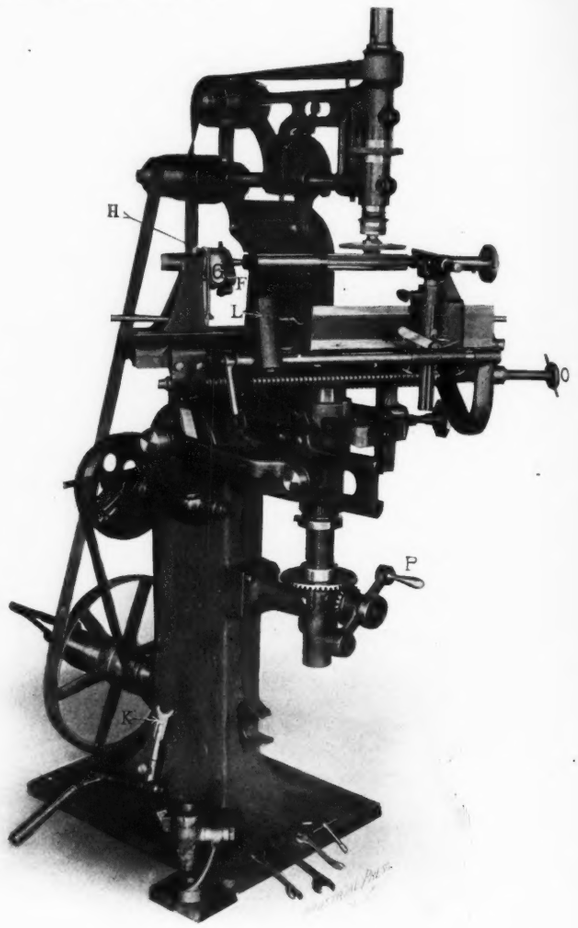


Fig. 1. Speed Box used on Mueller Radial Drill.

When grinding spirals the fork *K* is placed in the socket *L*, the prongs being placed in the spirals of the cutter. A spring shown wound around the collar *G*, holds the cutter blade up to the fork and, as the fork is stationary while the cutter travels, spiral motion is imparted to the cutter. The emery wheel works between the prongs of the fork, which does not leave the cutter during the process of grinding, one prong always remaining on to keep the cutter in place when the pawl feeds from one tooth to another. The angle of the bed with the spindle can be changed from 0 to 90 degrees and clamped fast wherever desired. The relative position of the cutter to the wheel can be changed by the screw rack *O* while the machine is in operation. This screw can also be used as a hand feed if necessary. The crank *P* is used for bringing the cutter up to the wheel and its hub is graduated in thousandths of an inch.



Automatic Cutter Grinder.

SPEED CHANGING DEVICE FOR RADIAL DRILLS.

The half-tone, Fig. 1, shows a new speed box, driven by a constant speed motor, that has just been brought out by the Mueller Machine Tool Co., Cincinnati, Ohio, and applied by them to their radial drills. The two long levers, shown in front of the box, operate four friction clutches, giving instantly the same four speeds as the usual step cones. The numbers cast on the lid of the box indicate in what position the levers should be brought for the different speeds. The small handle locks one lever while the other is in use.

The two levers, shown at *R* on the next page, Fig. 2, are used to engage the friction clutches *T*, by means of the forks *S*, with either of the gears *E*, *F*, *G* or *H*, on the motor-driven shaft *A*, and they mesh with gears *I*, *J*, *K*, *L* on the shaft *B*. Gears *K* and *L* also mesh into *N*, *P*, *Q*, *M*, giving power to shaft *C* which, through miter gears, drives the eccentric shaft *D* in the column. When reverse motion for tapping, etc., is required, the gear *O*, which is on a tumbler, is engaged with gear *L*, making gear *M* run in the opposite direction.

All starting or stopping of the machine is controlled by a loose ring encircling the column which, when moving the bar *X*, causes sleeve *W* to turn in its bearings and move the rack *Y*, and the rod *V* with the fork attached to its end, back and forth. This engages either of the friction gears *M* or *N* to the shaft *C*, and in changing from *M* to *N* double the speeds derived from the shaft *A* are delivered to the shaft *C*, and by using the back gears that are provided, the usual sixteen speeds are obtained on the work spindle. This speed box is also made to be driven by plain pulleys instead of a motor when desired.

STEEL MITER BOX.

The cut illustrates a new miter box that has just been placed on the market by the Goodell Manufacturing Co., Greenfield, Mass., and which is especially suited for pattern shop use. Being made entirely of steel it is calculated to last for a long time and its accuracy is insured. The back is formed in corrugations, ¼ inch deep by ½ inch wide, allowing perfect clearance for sawdust. Besides the angles usually provided for, by simply turning a lever this box can be set at any angle desired. The box is made in two sizes, either of which can be furnished with extra angle attachment to increase the angle above 45 degrees.

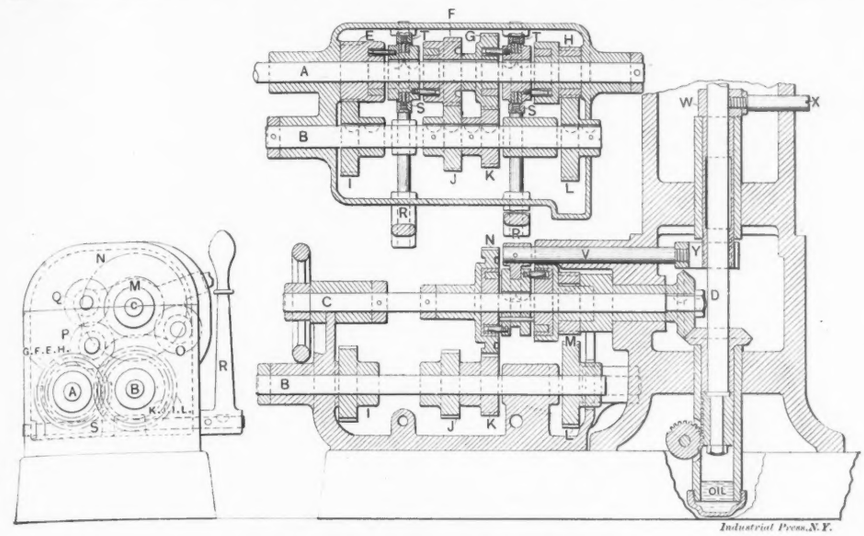
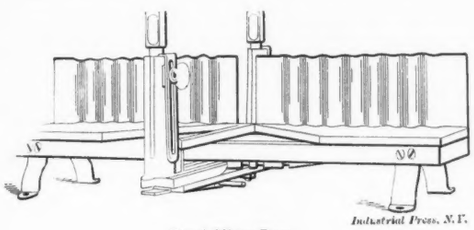


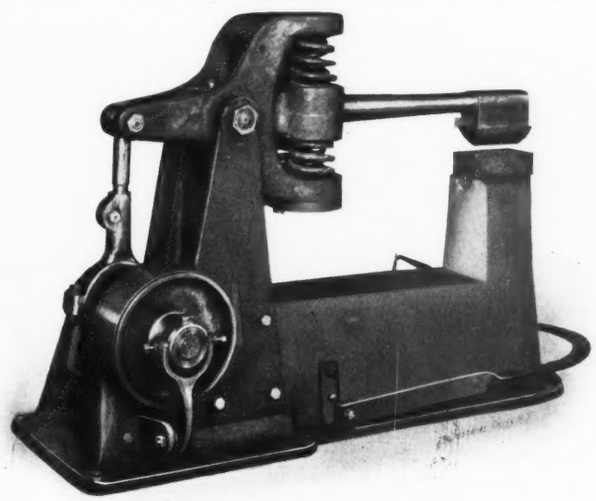
Fig. 2. Detail of Mueller Speed Changing Device.



Steel Miter Box.

THE "DAYTON" POWER HAMMER.

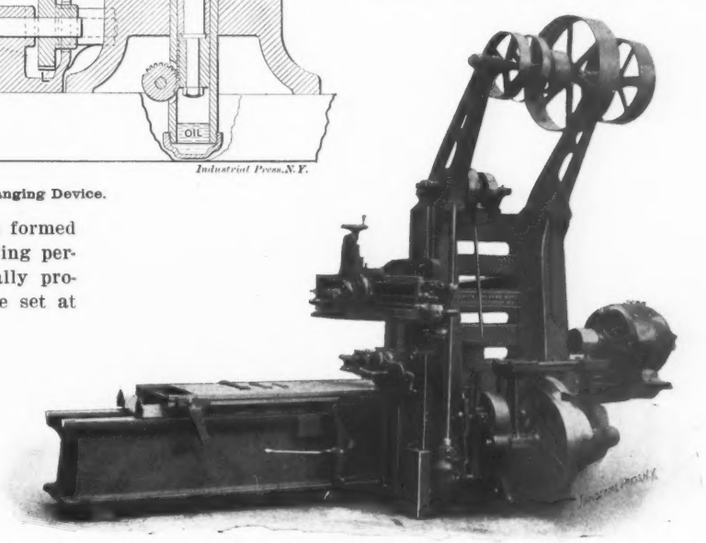
The cut illustrates the "Dayton" power hammer in the form in which it has lately been constructed with a view to fitting it for the use of blacksmiths and wagon makers, and in the larger manufacturing concerns where the smaller size has proved well suited to the requirements of the tool dresser. With the aid of this hammer it has been found economical to work up old scrap, such as horseshoes, etc., into bar stock for use in the shop. These hammers are now being made by the Miami Valley Machine Tool Co., Dayton, Ohio, in two sizes, weighing 900 and 1,500 pounds, respectively. Both sizes have a stroke of eight inches. The helve-head of the No. 1 hammer measures 2 x 4⅝ inches, and that of the No. 2 is 3¾ x 8 inches. Both sizes are belt driven and are operated in the usual manner by means of a foot lever.



The "Dayton" Power Hammer.

36-INCH MOTOR-DRIVEN OPEN-SIDE PLANER.

The Detrick & Harvey Machine Co., Baltimore, Md., have lately adopted the application of electric drive for their open-side planers, the method by which this is accomplished being shown in the accompanying photograph, which is an illustration of their 36-inch motor-driven planer. Upon the top of the post is placed a countershaft from which the planer is driven in the usual manner. This countershaft, in turn, is driven from the motor which is carried on a bracket at the back of the post. The countershaft is usually furnished with a flywheel or heavy rimmed pulley of sufficient weight to reverse the platen without causing excessive fluctuations of load upon the motor.



Motor-driven Open-side Planer.

A SPIRAL GEARED HANGER.

To obviate the troubles incidental to the use of a quarter turn belt for driving shafting at right angles, the Diamond Clamp & Flask Co., Richmond, Ind., are placing on the market the spiral geared hanger shown in Fig. 1 on next page. Fig. 2 shows a section through the spiral gears by which the power is transmitted. They are machine molded so as to insure easy and quiet running. As will be seen in the cut, the thrust of the gears is taken on ball thrust bearings, thus reducing the friction to a minimum. The casing not only efficiently encloses the gears but it is cored to form an ample oil pocket having return channels to insure a proper circulation of the oil. This design of hanger besides affording a means for transmitting power at right angles combines with it an adequate support for both of the shafts. These hangers are also built for transmitting from vertical to horizontal shafts at right angles, and they are also furnished with tight and loose pulley, thus fitting them for application to countershafts.

ANGLETTES FOR THE DRAFTSMAN.

The "anglettes" shown on next page are designed for use in lieu of a protractor in drawing angles, and will be found of great convenience in the drafting room. They are made of

celluloid and thereby possess all of the advantages of the transparent triangles. The set consists of ten pieces, each four inches in length, having the upper edge accurately cut to make an angle with the base. The angles range from 1 degree to 10 degrees inclusive and the set may be augmented if desired, by the addition of ½ and ¼ degree pieces. The degree of each anglette is plainly stamped upon its surface, and since they are solid there is no possibility for the angle to change. Used in conjunction with a 30-degree triangle, it is possible to obtain any degree without using more than two anglettes at a time in the combination. Some illustrations of how the pieces are used are shown in Fig. 2. Each set is neatly packed in a substantial box. They are being placed on the market by Jas. Dangerfield, Hartford, Conn.

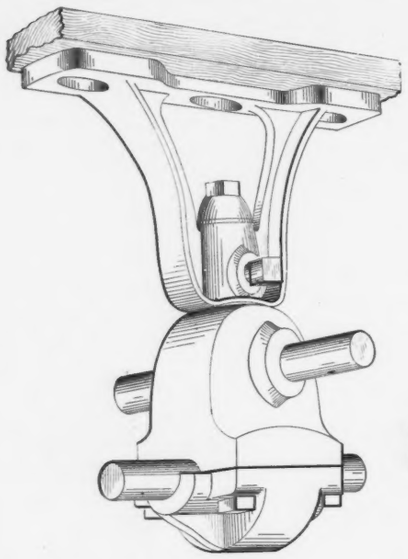


Fig. 1. Spiral-geared Hanger

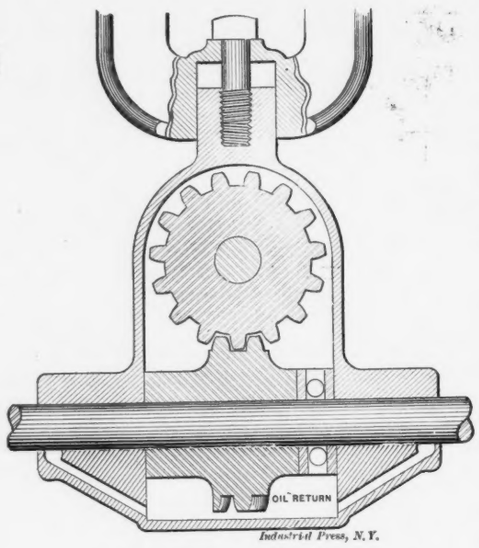


Fig. 2. Section through Hanger

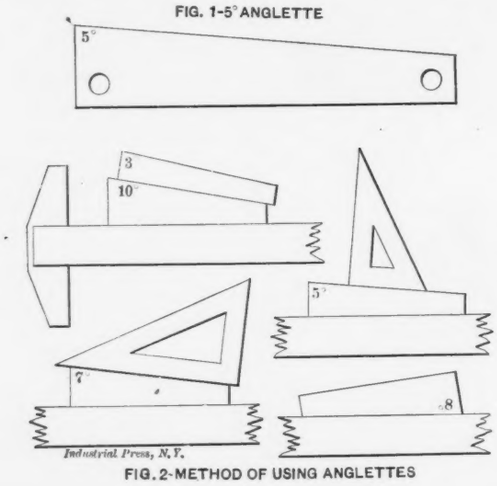


FIG. 2-METHOD OF USING ANGLETTES

* * *

Just at the present time the "anti-wireless" partisans seem to be having the best of the battle that has so far been chiefly waged on paper. The wireless service instituted by the Marconi Co. to the London *Times* has suddenly been discontinued without explanation beyond that some part of the apparatus had broken down, but of course this explanation is lame and impotent. The claim of the Marconi Co. that they have a system of "tuning" by which signals being transmitted to any other selected station cannot be interfered with or intercepted by rival stations, received a severe setback a few days ago. Dr. Fleming, who is connected with the company, was demonstrating the receipt of a message from Cornwall to London when the word "rats" interpolated itself in the message much to the professor's disgust and to the delight of his opponents. The professor denounced the action as a piece of "scientific Hooliganism" and called for the perpetrator to reveal himself. Mr. Nevil Maskelyne at once announced himself as the "villian" in a letter written to the *Times*, and chuckled over his success in having proven that the claims of the Marconi Co. as to their infallible selective system, were scarcely based on fact. Mr. Maskelyne also stated that a message received from Poldhu by the Royal Institution in the afternoon had been practiced from 11 o'clock in the morning and that fifty horse power were required in sending it. Meanwhile the public anxiously awaits the advent of the wireless telegraph and telephone.

* * *

A United States consular report from Coburg, Germany, describes an interesting product made from milk casein which is called "galalith" or "milk stone." This product is used as a substitute for horn and celluloid in the manufacture of combs, knife handles, balls, chess figures, dominoes, ferrules, slabs in imitation of marble, etc. An advantage that the new product has over celluloid is that it does not ignite readily and has no odor. It is largely impervious to water, being about on a par with horn in this respect. It is expected that it will be a valuable addition to the electrical industries as an insulating material.

* * *

NEW TRADE LITERATURE.

THE NEW ERA IRON WORKS CO., Dayton, O. Illustrated catalogue of the New Era gas engines, full particulars of which are here given. These are built in sizes from 5 horse power to 125 horse power.

THE GARVIN MACHINE CO., Spring and Varick Streets, New York. Booklet calling attention to the very complete stock of machine tools carried. These include drills, shapers, lathes, boring mills, etc.

THE ROE STEPHENS MFG. CO., Detroit, Mich. Catalogue and price list No. 9 of valves in brass and iron. This is very complete, 103 pages being devoted to valves of every description, all of the company's own manufacture. A telegraph code is given in the back.

THE FAIRBANKS MACHINE TOOL CO., Springfield, O. 1903 catalogue and price list of lathe, planer and shaper tools. The Fairbanks universal swinging cut-off tool, planer tool, threading tool, adjustable boring tool attachment, and various side tools, etc., are described and illustrated herein.

THE NATIONAL BRAZING CO., Dayton, O. Booklet calling attention to the "Eureka" brazing compound for the repairing of broken cast-iron castings. The company here state that it does not require an expert to use "Eureka," but that any brazier, machinist or toolmaker can use it.

WYMAN & GORDON, Worcester, Mass. "A short story of Eli Whitney," being an interesting sketch of this great mechanic and inventor. Whitney introduced the system of interchangeable parts, which has made possible the production of any and all machinery in large quantities, with great speed and the highest precision.

THE GOHEEN MFG. CO., Canton, O. Catalogue of the company's protective paint, called "carbonizing coating," which shows examples of this coating as applied to roofs, water pipes, blast furnace cupolas, trestles, gas tanks, bridges, etc., in fact, wherever iron and steel are used.

THE GODDARD MACHINE CO., Holyoke, Mass. Illustrated catalogue of grinding and polishing machines. These are of various sizes and styles. A combination knife grinder, tool grinder and saw gummer is shown for use in shops where a variety of work is required of such a machine.

THE AMERICAN SPIRAL PIPE WORKS, Chicago, Ill. Catalogue and price list of spiral riveted pipe for water lines, exhaust steam work, etc. This is manufactured in sizes from 3 to 40 inches in diameter. Much information is given concerning this product and twelve pages of valuable tables and other data also appear.

THE JOHN M. ROGERS BOAT, GAUGE & DRILL WORKS, Gloucester City, N. J. Catalogue "E" of rock drills for work in quarrying, shaft-sinking and tunnel driving. These drills are operated either by steam or compressed air. A number of cuts show the drills and their details. The "Eureka" valve and steam chest is a feature of this drill to which they would like to call special attention.

THE HOGGSON & PETTIS MFG. CO., New Haven, Conn., Leaflet calling attention to the company's latest catalogue, which treats of chucks. They request customers to state on their next order how many desks they have that are not provided with pin cushions, which useful adjunct (a sample of which we have received) we take it they will supply.

THE GENERAL PNEUMATIC TOOL CO., Montour Falls, N. Y. Bulletins Nos. 53 and 54. No. 53 treats of the company's column riveting machine for riveting of columns and general riveting. No. 54, of their combined stationary and portable pneumatic riveter which is adapted to shops where the amount of riveting done will not warrant a stationary and a portable riveter.

THE PIKE MFG. CO., Pike Station, N. H. Illustrated catalogue of scythe stones, oilstones, grindstones, axe stones, etc. These are shown in a large variety and for many purposes. The company has been established since 1823, and their factories and quarries are at Pike

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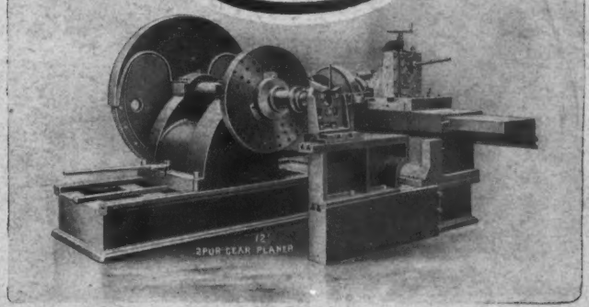

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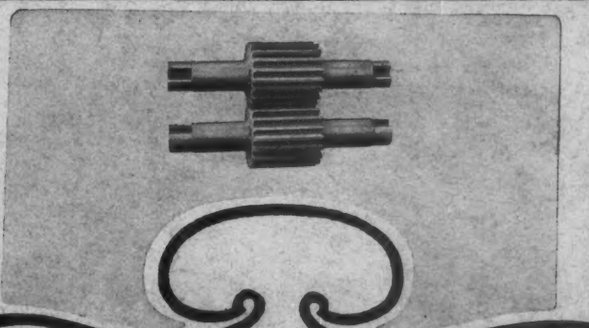

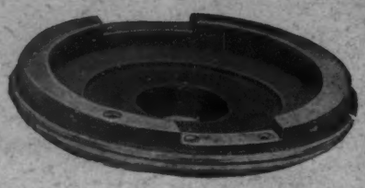

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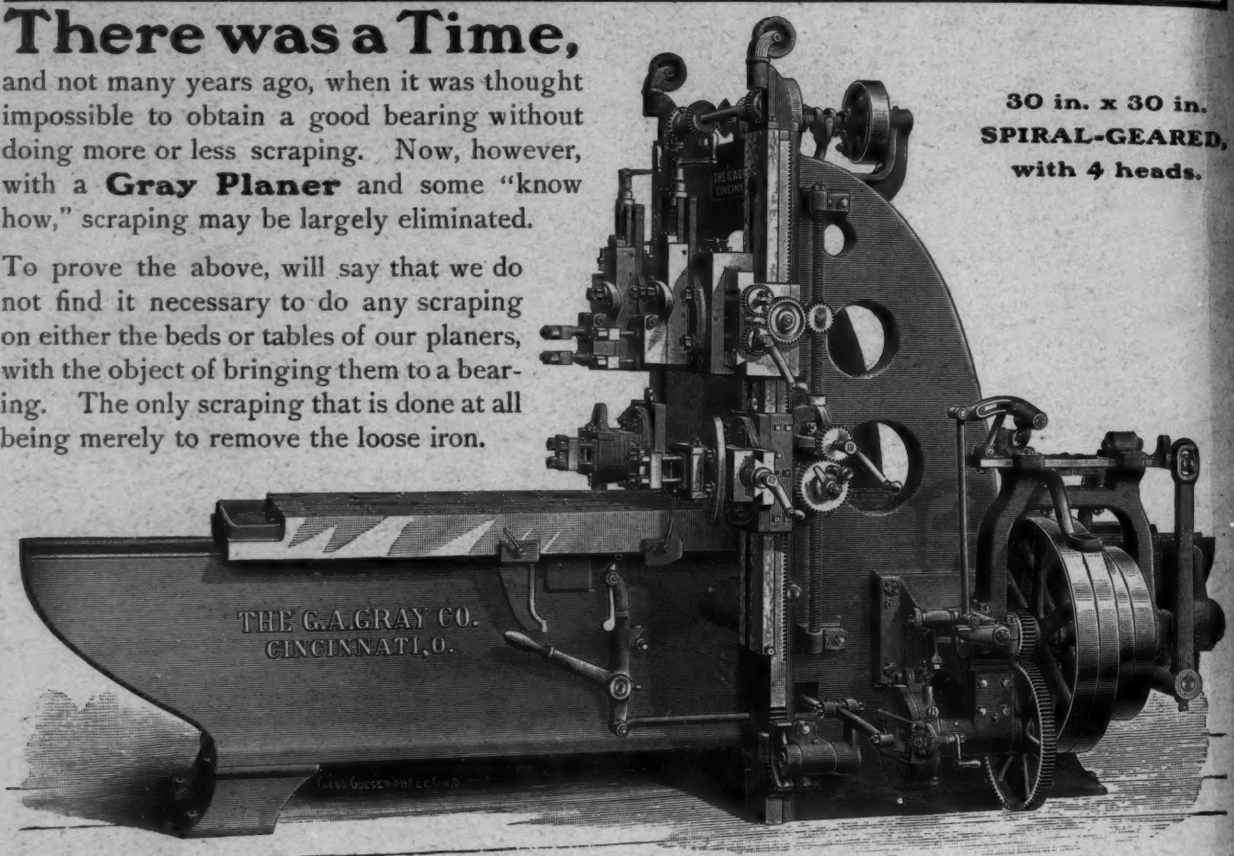

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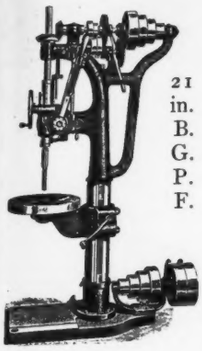

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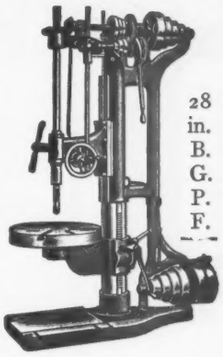

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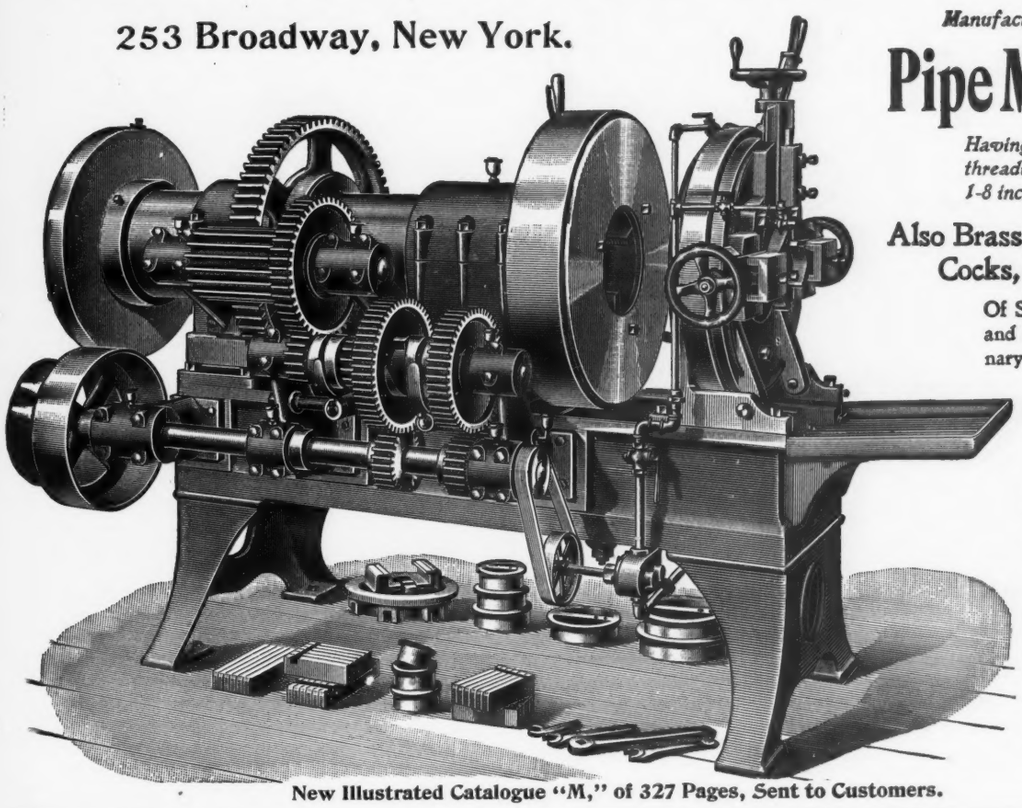

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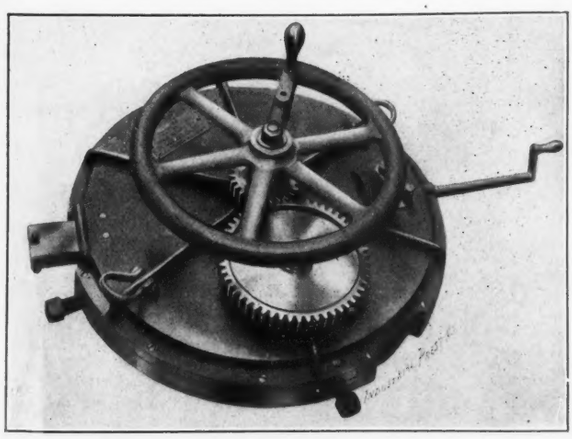

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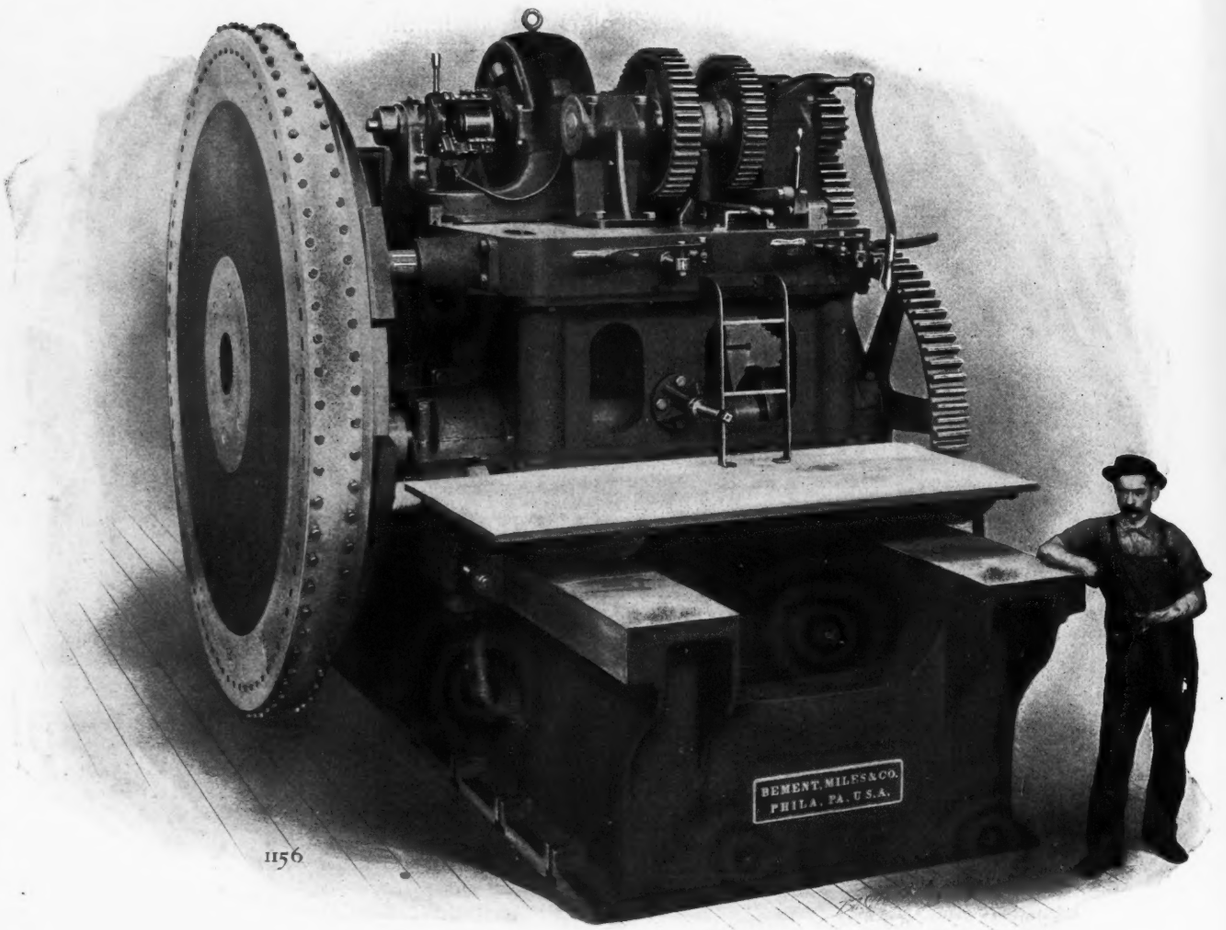

Ten foot Rotary Planing Machine, Motor Driven.

Regular saddle traverse 16 feet. Length of Bed 26 feet. Outside diameter of Face-plate 10 feet, 7 inches, with steel band shrunk on, through which set screws extend for clamping tools.

THE FACE PLATE is internally driven by gear and pinion near its outside diameter and has three cutting speeds with each speed of the motor.

THE ENTIRE GEARING is mounted on a platform directly over and carried by the saddle so that the bed is a plain casting free from all mechanism.

Machine as shown is prepared for attaching to a floor plate and bed with lugs for lifting by crane.

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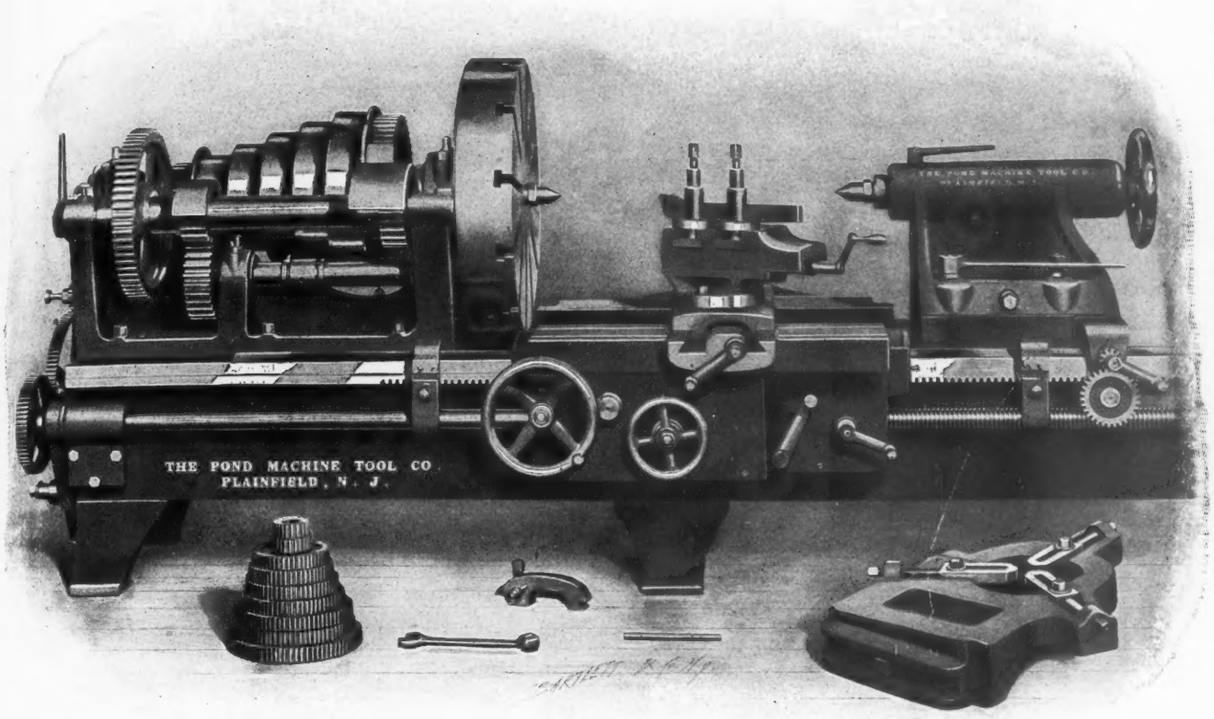
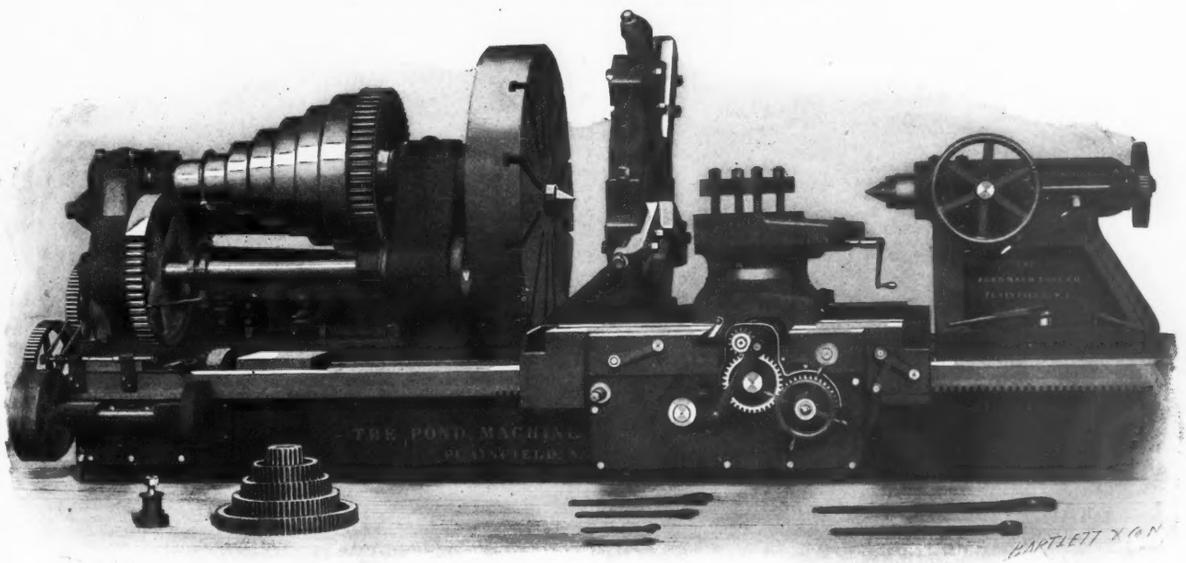


32-inch Triple Geared Pond Engine Lathe.

Regularly manufactured in stock sizes from 28 inch to 84 inch swing over ways.



72-inch Pond Forge Lathe.

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Pond Machine Tool Works, Plainfield, N. J.

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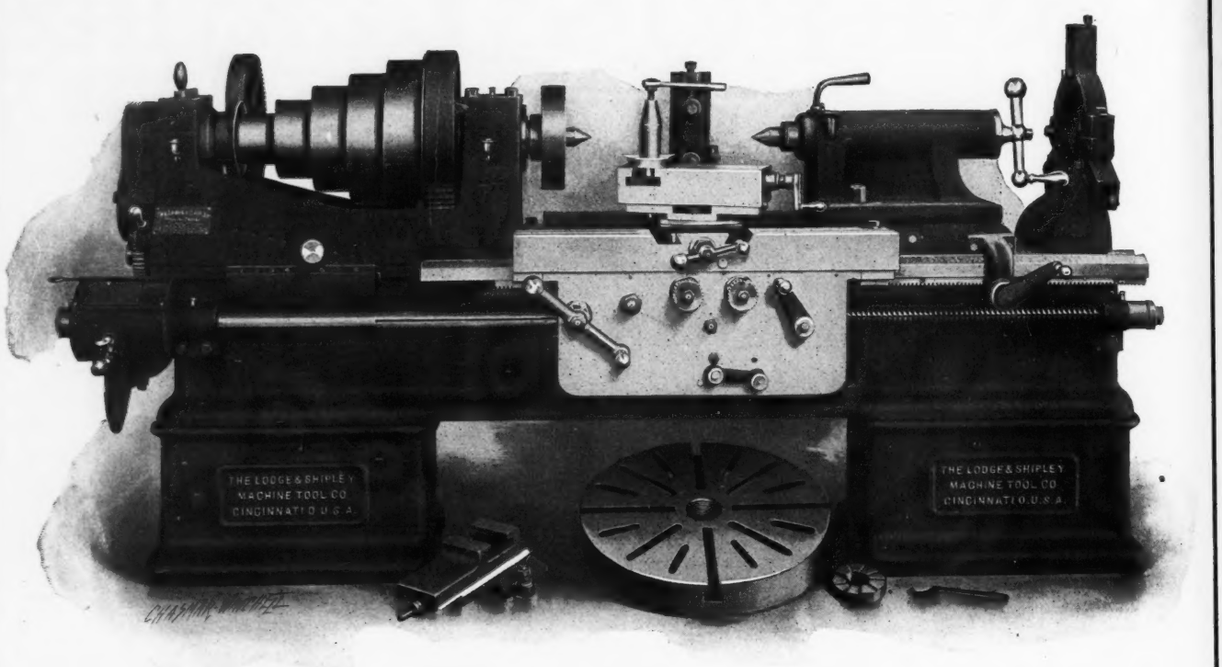

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Because users recognize their merits, their strength, their solidity, their capacity for turning out 25 to 40 per cent. more work, their possibilities for living a long life under hardest possible service. Their capability for use in connection with high speed steels.

SIZES, 14-INCH TO 48-INCH SWING.

Our Catalogue "N" just received. Write for a copy.

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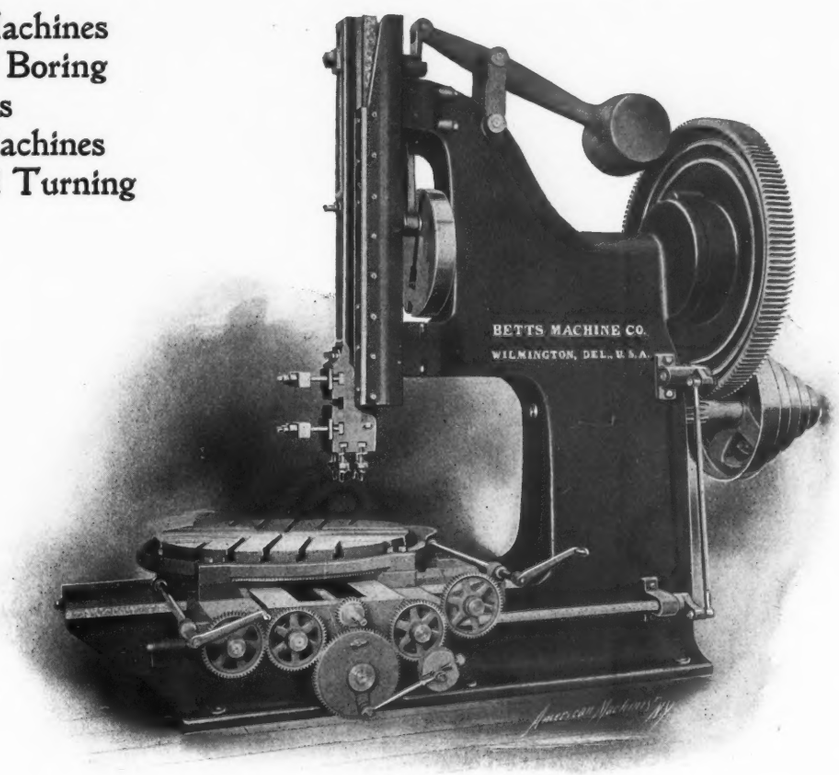

Slotting Machines—Combining all modern improvements and many exclusive advantages. We make them in sizes 8 inch, 10 inch, 12 inch, 15 inch, 18 inch, 21 inch and 24 inch. The sizes above 10 inch are always made with the adjustable Guide and Relief Tool Apron.

The above cut shows the 21 inch machine. It has a stroke of 21¾ inches, with adjustment for any position and length of movement. The Cutting Bar has eight speeds, is counterbalanced, and returns 2¾ to 1. Distance from frame to front side of cutting bar is 42 inches, making it possible to slot in center of 88 inches. Feeds are positive, self-acting in all directions, and operate at upper end of stroke; the arrangement of handles and other feed works is such that the operator can command full use of them from one position, and at the same time watch the cutting tool. Compound Table has an adjustment of 48 inches longitudinally, and 44 inches transversely, and supports a revolving table 48 inches in diameter, secured in any position by corner clamps. This table is graduated, and so arranged that the worm can be disengaged for ready adjustment of work.

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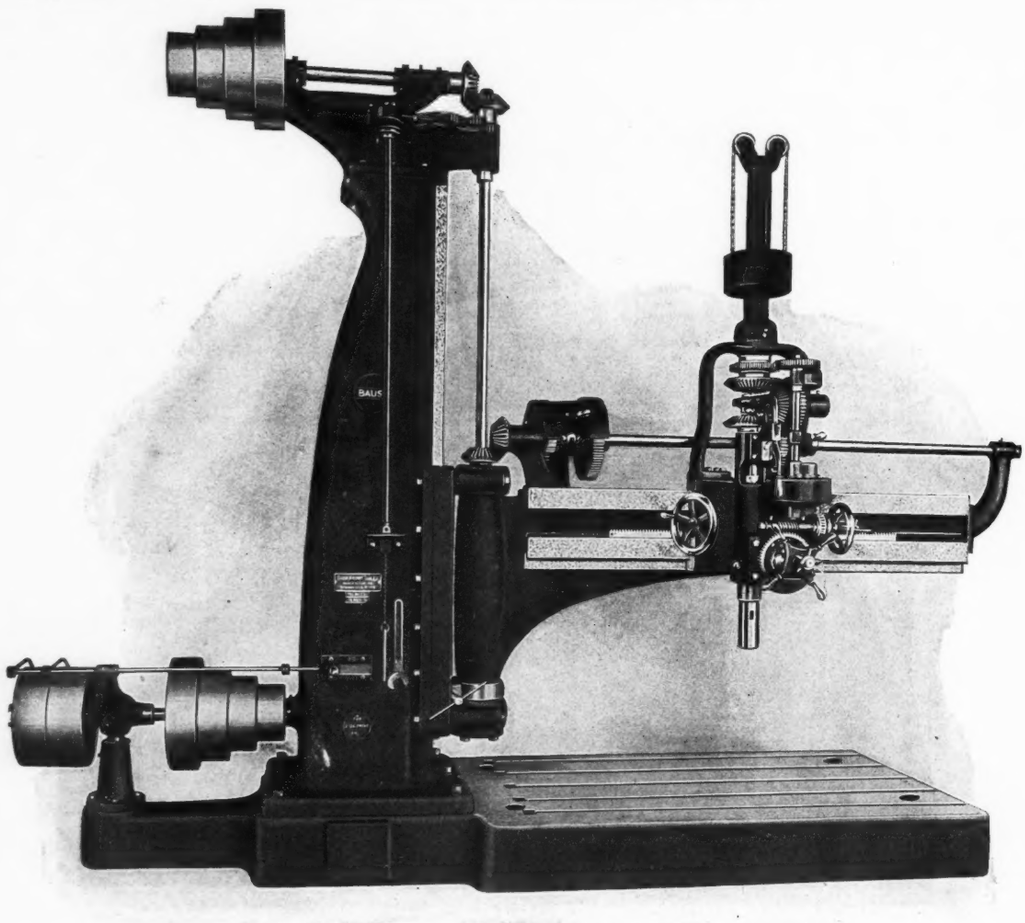
Baush Radial Drills

Are built in sizes from 5 foot arms up to machines having 14 foot arms and drilling to center of a 28 foot circle.

They are made belt or gear driven and are furnished with or without tapping attachments.

The gear driven machine, illustrated in cut below, shows our 5 foot geared machine which has every feature necessary for drilling, boring and tapping a hole rapidly.

Our drills weigh more than any other radial on the market of same size, having great strength and stiffness, which means accuracy.



FIVE FOOT GEARED RADIAL WITH TAPPING ATTACHMENT.

We have applied more power than ever, using all steel gears throughout.

Back gears can be thrown out or in without the use of a locknut.. All geared machines have quick change feed.

The tapping attachment can be stopped, started and reversed instantly. We do not depend on friction.

Write for further particulars.

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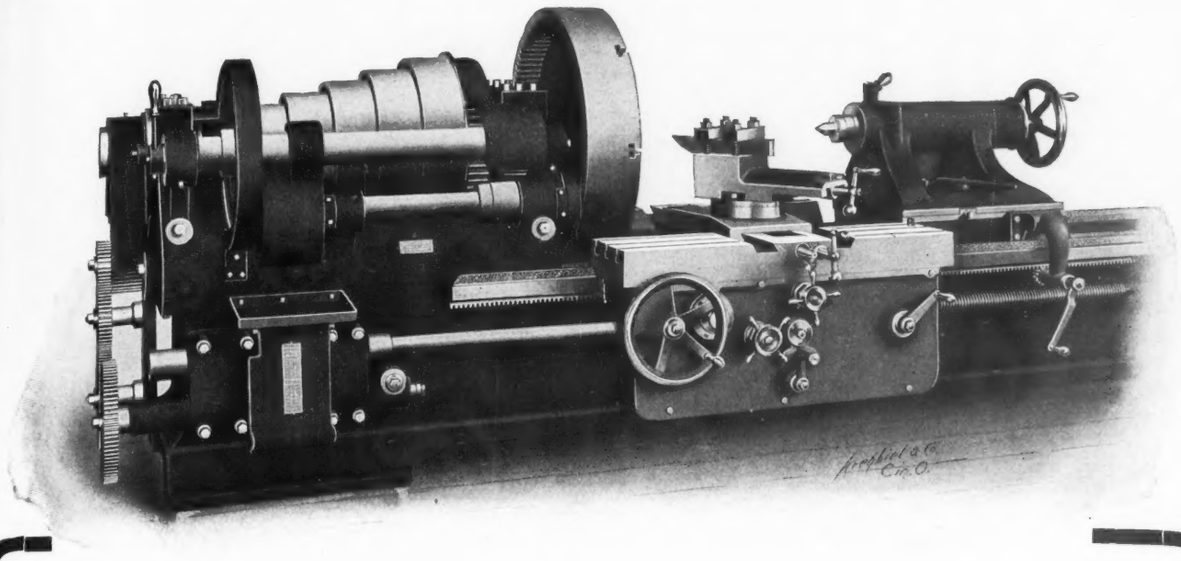
AGENTS: Manning, Maxwell & Moore, Boston, Cleveland, Chicago, Philadelphia, Pittsburg and New York. Chas. Churchill & Co., London, Glasgow, Manchester, Birmingham, Newcastle-on-Tyne. Fenwick Freres & Co., Paris.



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A 6-inch Spindle, having 3-inch hole, and manufactured from the highest grade Crucible Steel, is mounted in Bronze Boxes, and contained in a Headstock of massive proportions. The Back Gears are conveniently located on the front of Head, delivering the power direct to the cutting tool.

Fifteen Spindle Speeds are provided with three rapid changes of feed for each speed without the removal of a gear. Provision is made for a wide range of feeds and threads, which is further augmented by our Coarse Screw Cutting Arrangement for cutting spirals. The feeds are reversed from the Apron, which is Double, and the compound Rest has Angular Feed of 12 inches.

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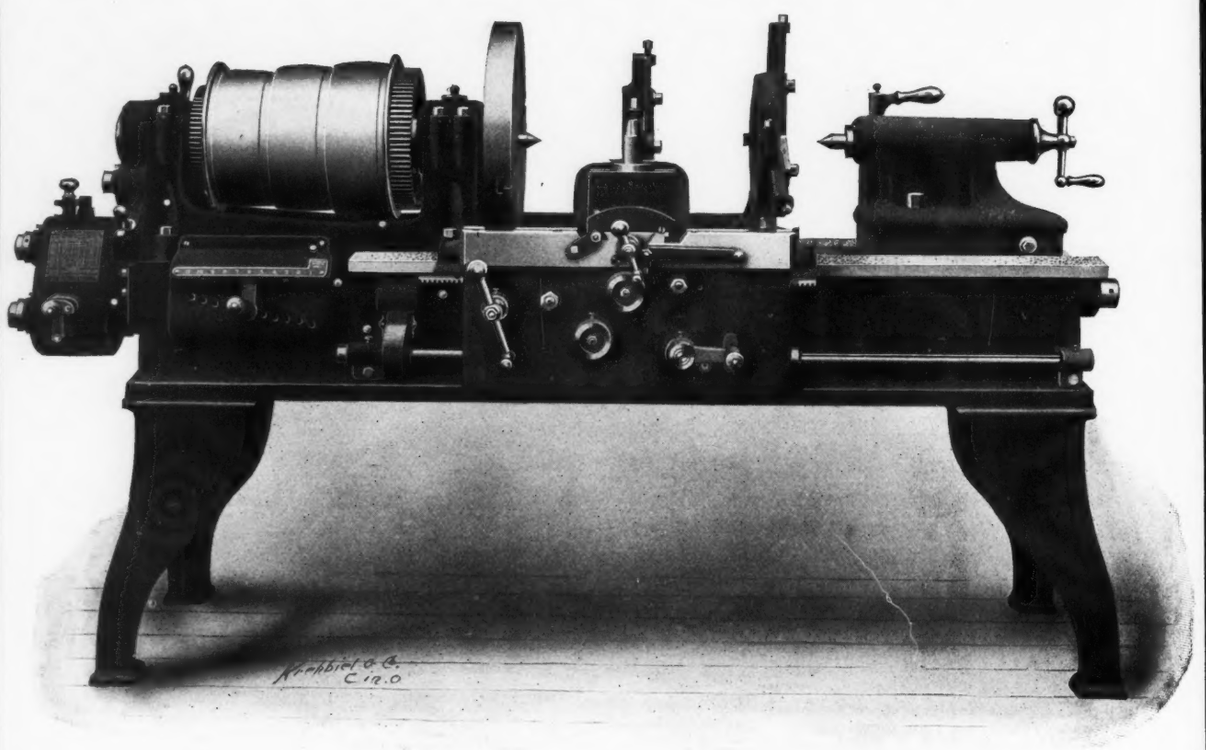

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is so greatly in excess of that of the ordinary lathe, for high speed work from 1 inch to 4 inches diameter, that net profits resulting from its continuous use are more than twice as great as on any ordinary lathe of similar size.

Send us blue prints of your work of these diameters; let us determine, by practical tests, the time of production on our lathe; then compare this with your very best present records. The difference will astonish you and convince you of the exceptional value of this machine as an economical investment. Send for detailed literature on this remarkable machine.

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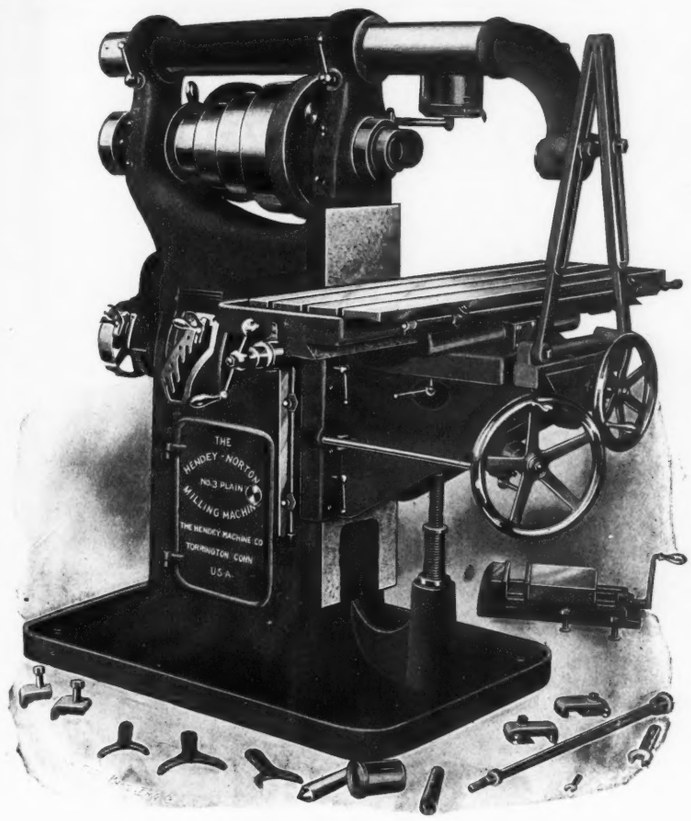

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You may have in place of the curved overhanging arm, the straight bar with removable center support for arbor.

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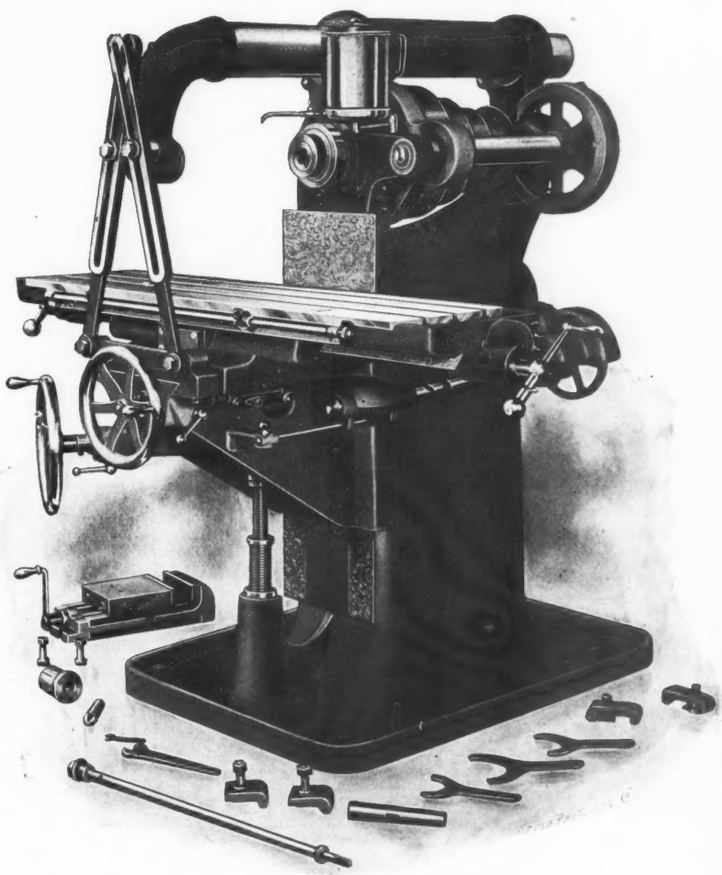

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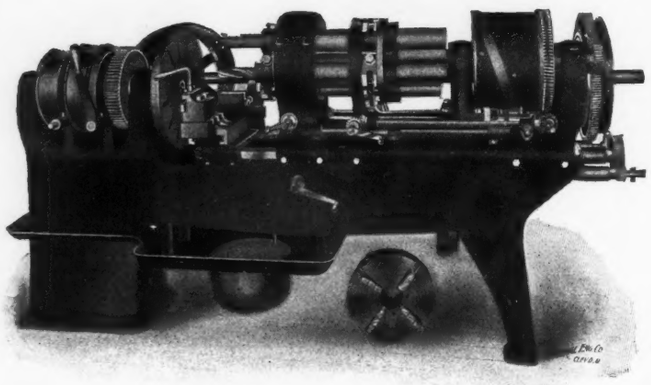
Cleveland Automatic Chucking Machine.



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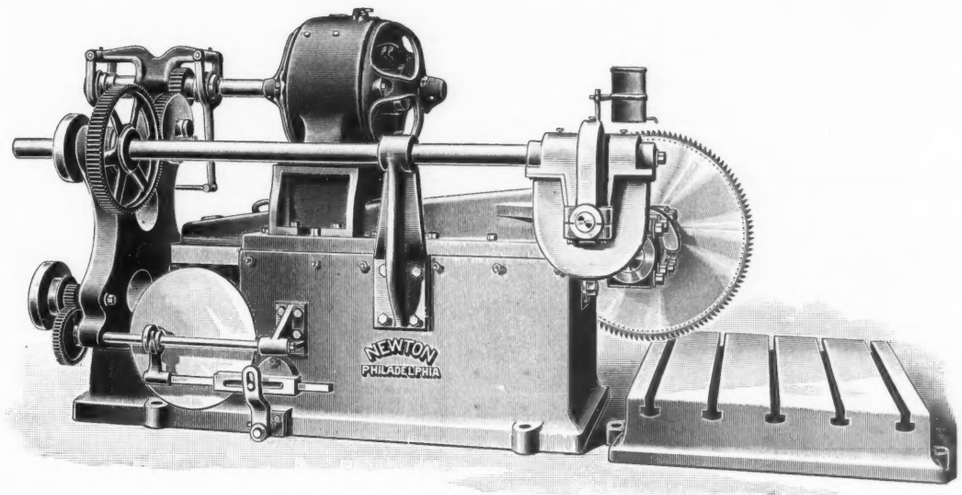

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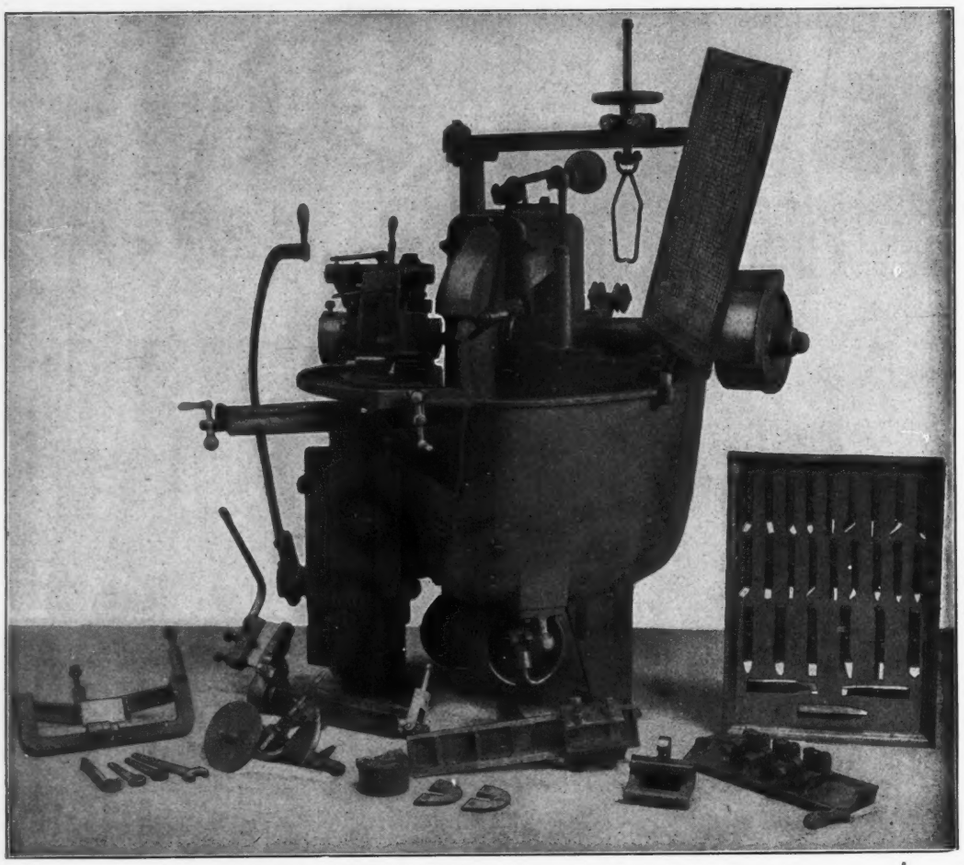

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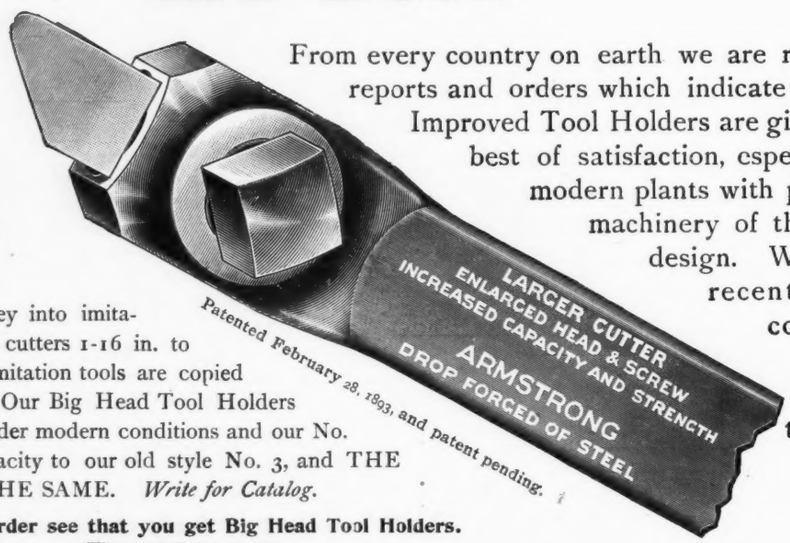

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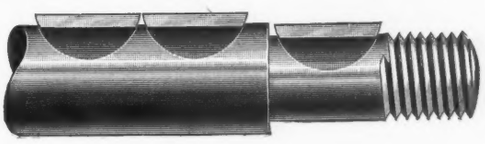

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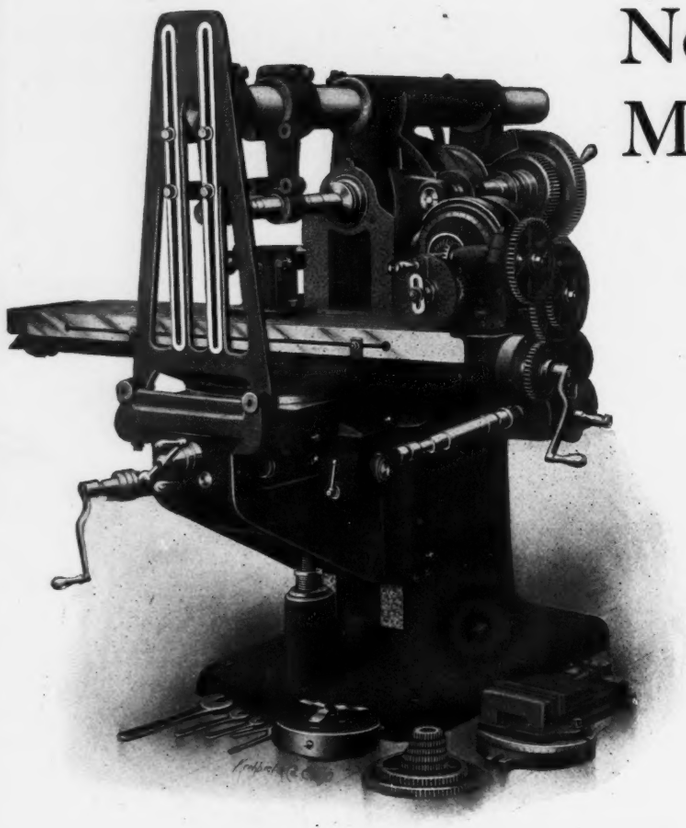


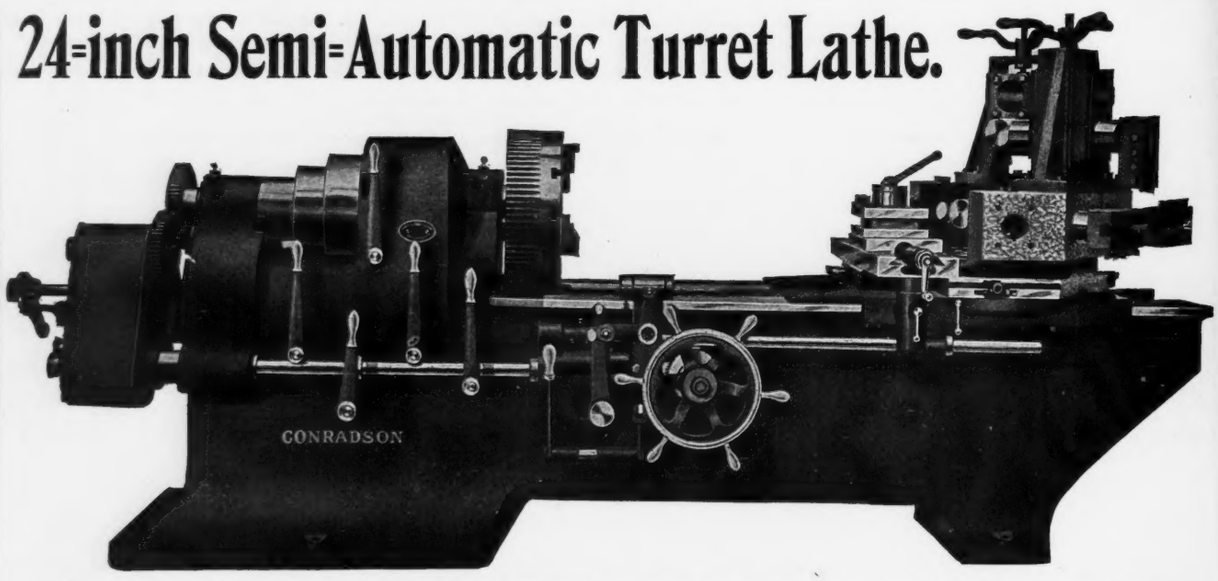
No. 3 Universal Milling Machine

THIS machine has the spindle driving power. It is double back geared, giving it double the power of a single back geared machine. It has a feed range from .006 to .255 per revolution of spindle. The feed is driven entirely by spur gears. All changes of feed can be made without stopping the machine. One handle does the business. Spindle power is sufficient to pull a cut when the limit of feed is taken. It will do this with a surface mill. If you want to test a miller the surface mill is the mill to test the machine. Any machine made will pull a heavy cut when using a face mill. Most work cannot be milled this way. We would like to convince you of these facts and the superiority of our machine. If interested in powerful, work-producing, time-saving, money-making milling machine practice, write us for booklet.

The R. K. Le Blond Machine Tool Co.

CINCINNATI, OHIO, U. S. A.

24-inch Semi-Automatic Turret Lathe.



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We build turret lathes in several styles and sizes. Write us for particulars.

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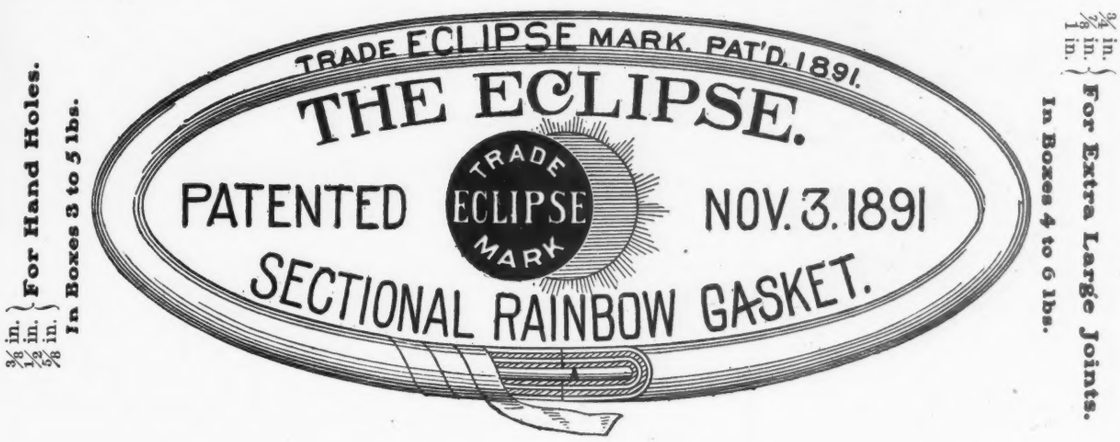
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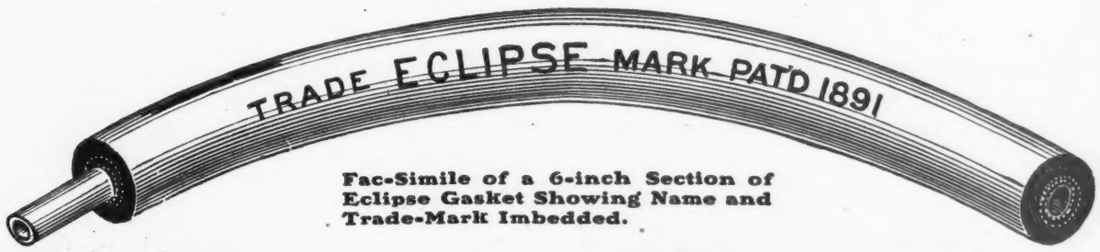

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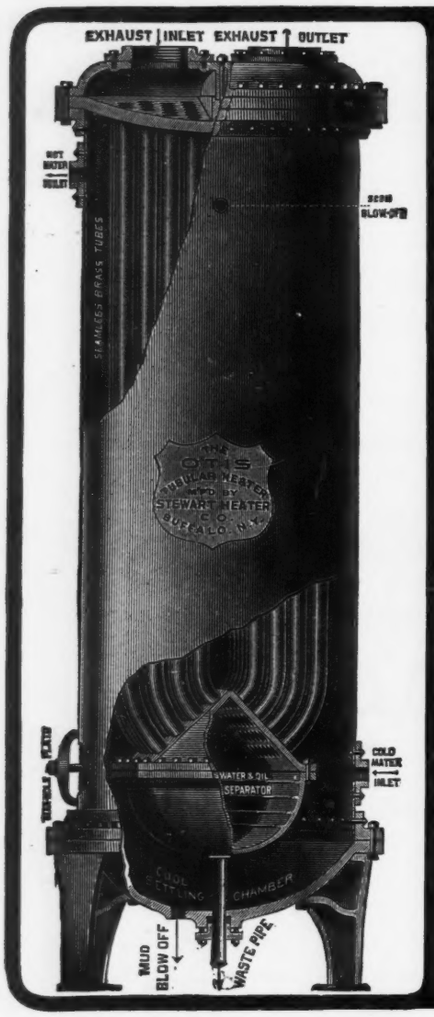

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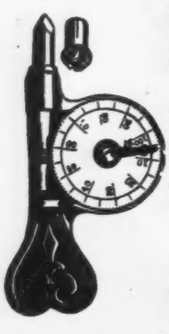

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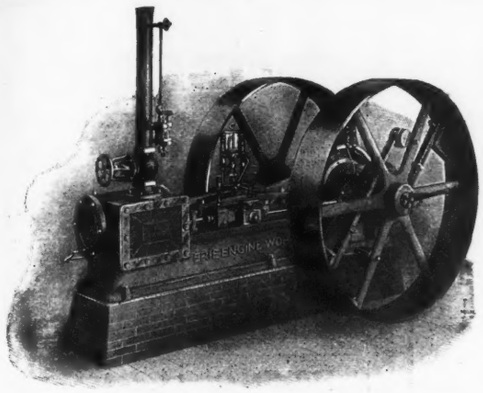

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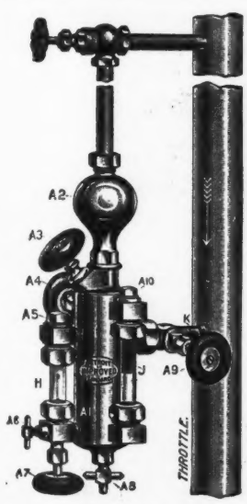

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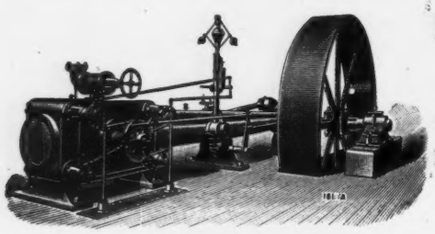

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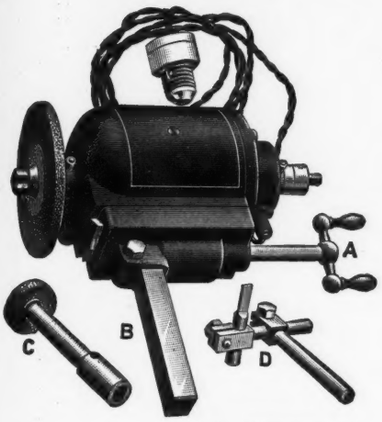

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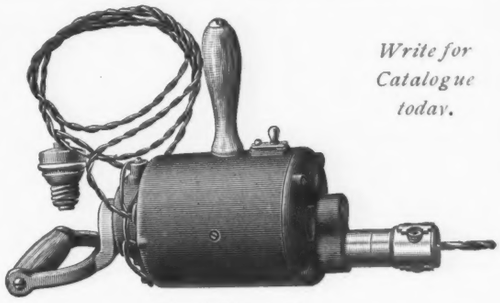

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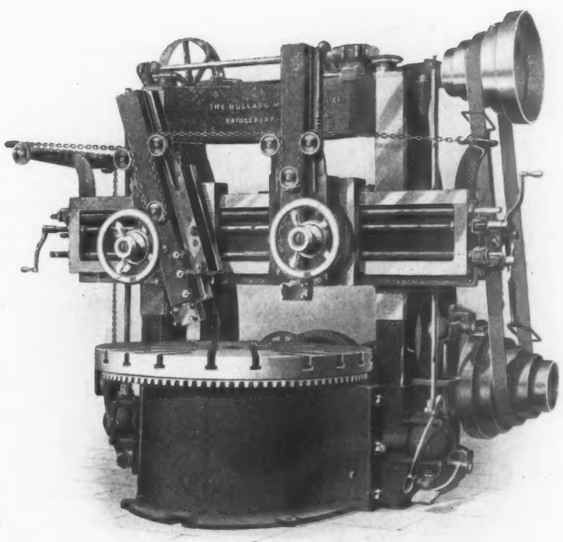

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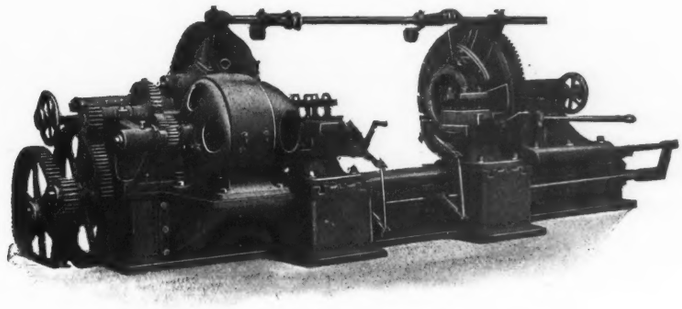
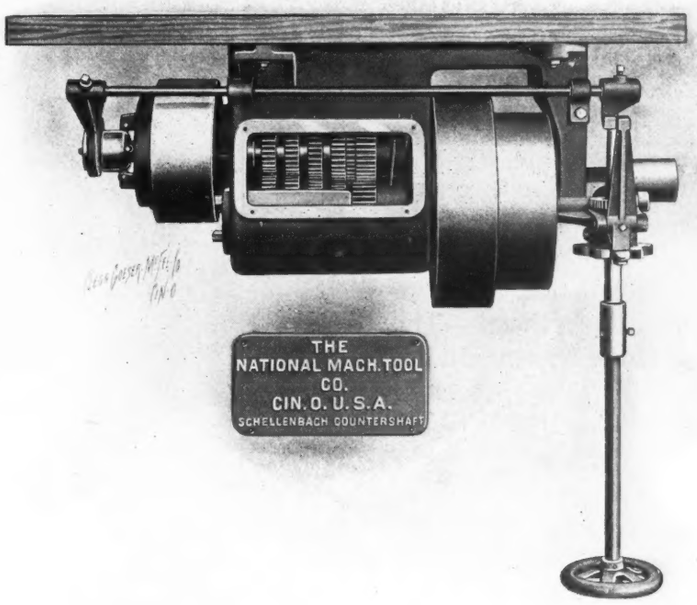
Electrical Equipment for Machine Shops

The C-W System is being installed in many large shops. It uses standard apparatus and gives an economical method of drive.



Crocker-Wheeler Company
Manufacturers and Electrical Engineers,
Ampere, New Jersey

Four Cutting Speeds For Your Planer



Ranging from 20 to 45 feet per minute, will open your eyes to a surprising opportunity to cut cost in your planer department.

Our Special Variable Speed Device for Planers has *Four Positive Cutting Speeds from 20 to 50 feet per minute and returns the Table at 70 feet per minute.*

One lever controls every movement.

The gears are of steel, entirely enclosed. Oiling devices are efficient and simple and the casing is oil and dust proof.

Write for Our Variable Speed Countershaft Circular

The National Machine Tool Company, Cincinnati, Ohio

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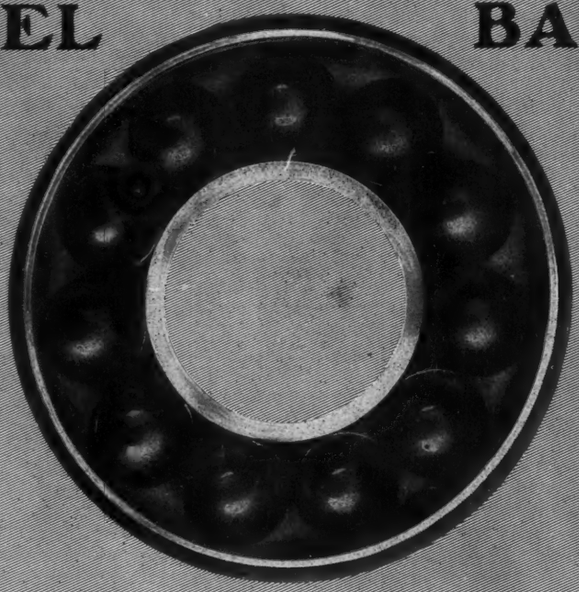

Something more than a micrometer is needed in order to surely distinguish good balls from bad ones.

The test of quality lies in service, not in gauging. The best balls are known as "High Duty." And we make them.

FEDERAL MANUFACTURING COMPANY
CLEVELAND BALL FACTORY—Cleveland

The American Steam Hammer

—BUILT BY—

Monighan Machine Works,

813-823 Carroll Ave., Chicago, Ill.

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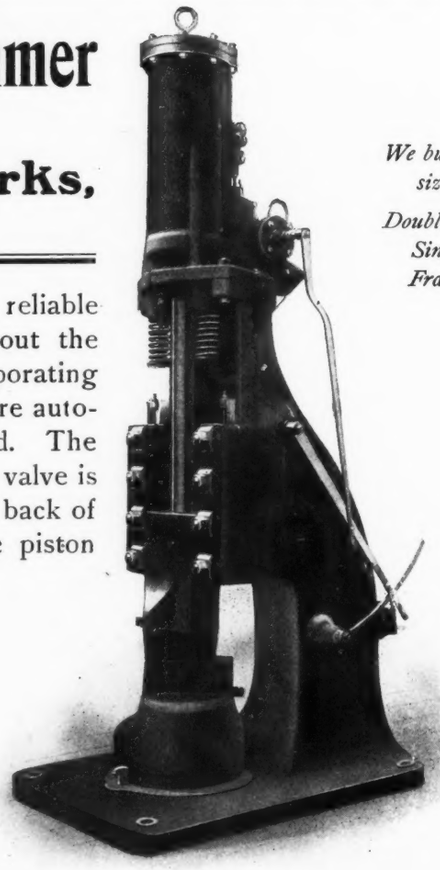
Our 400 and 600 lb. steam hammers are equipped with foot treadle, by means of which the smith can operate the valve gear with his foot when forging short pieces, light work, finishing, etc.



We build all sizes.

Double and Single Frame.

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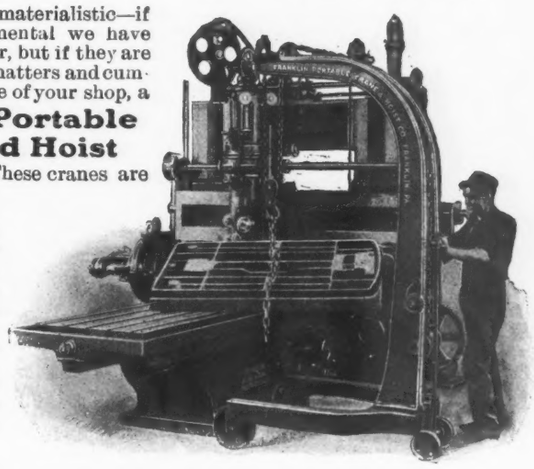
WEIGHTY MATTERS

may be mental or materialistic—if they happen to be mental we have no suggestions to offer, but if they are good solid material matters and cumbering the floor space of your shop, a

Franklin Portable Crane and Hoist

is what you need. These cranes are strong, easily operated, go into the corners and out-of the way places your traveling crane can't reach, and enable one man to handle a thousand pounds as easily as he would one hundred. One of the conveniences no model shop should be without.



Catalogue on request.

The Franklin Portable Crane & Hoist Co.
FRANKLIN, PA., U. S. A.

The Celebrated LUFKIN

Steel Rules, and Measuring Tapes

excel all others for accuracy, quality and reliability. Made by the

LUFKIN RULE COMPANY, SAGINAW, MICH., U.S.A.

For Sale Everywhere.

THE LUBRICATING METAL CO. NOHEET TRADE MARK. NEW YORK.

Noheet Metal

(Tempered Lead.)

The toughest babbit metal on the market.

The metal every engineer is looking for.

Lead contains less qualities which cause friction than any other known metal and is a lubricant in itself.

NOHEET is made under a process of hardening lead, without the use of antimony, tin, zinc or copper, all of which cause friction, especially antimony, which is used by all metal manufacturers to harden all grades of babbit and anti-friction metals, not only causes friction, but makes the metal brittle, and all brittle metals will flake and crystalize. NOHEET will stand up under the heaviest class of machinery without crushing out.

NOHEET can be remelted many times without injury, which cannot be done with any other metal without adding new material.

NOHEET is absolutely different from any other babbit or anti-friction metal and is well worth a trial.

Write for particulars and price.

THE LUBRICATING METAL COMPANY
141 Broadway - NEW YORK.

Practice makes Perfect.

We are not new in the business—we learned our trade before some of you were born—and we have been building

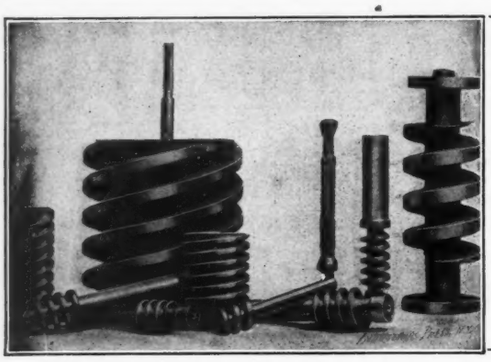
Special Machinery

so long we know just how to do it, and how to get the best results for the least money. Besides our experience we have a plant and equipment that is as complete as energy and capital can be make. Every device to turn out modern work in the modern way and at modern prices.

If you have Special Machinery of any kind to build, we are in a position to do the work on contract, and do it to your satisfaction. Write us for estimate.

The Turner Machine Company,
DANBURY, CONN., U. S. A.

Founded 1859. Denton and Stockport, England.



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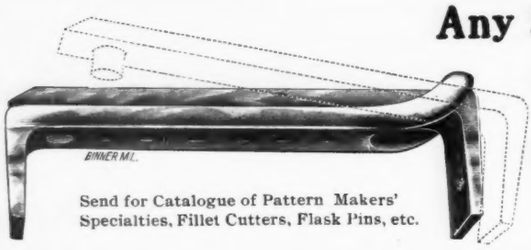
8 in. diameter, 8 in. long, 6 in. lead. Single, Double, Triple or Quadruple.

THREADED IN 94 MINUTES WITH THE AUTOMATIC THREADING LATHE.

We make these LATHES for all sizes SCREWS OR WORMS.

Output Guaranteed.

Automatic Machine Co.
BRIDGEPORT, CONN., U. S. A.



Any Size You Need.

Fraser's Adjustable Malleable Iron

Flask Clamp

is always ready, saves a world of time and trouble.

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Milwaukee Foundry Supply Co., Milwaukee, Wis.

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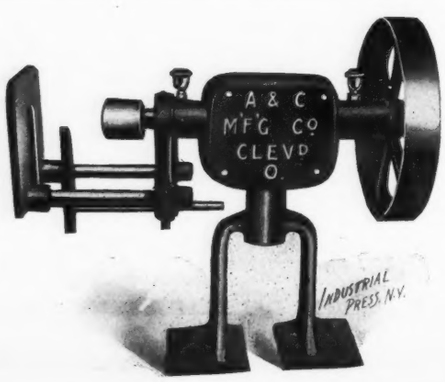
The No. 2 automatic tapping machine will tap holes up to one-half inch, and can be fitted with any style chuck, or, if desired tap holders of any required size can be furnished in place of chuck. It has automatic reversing device, and a sliding guide for work which is of great advantage in accurate duplicate tapping.

By substituting a die for the chuck the machine is equally valuable for thread cutting.

Write us for further details.



The A. & C. Mfg. Co.
26 Noble St. Cleveland, O.

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Hurlbut-Rogers Mche. Co., So. Sudbury, Mass.
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Tanite Co., Stroudsburg, Pa.

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Garvin Mch. Co., New York.
Gleason Tool Co., Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Pratt & Whitney Co., Hartford, Conn.
D. E. Whiton Mch. Co., New London, Conn.

For Alphabetical Index, see Page 24.

Chestnuts and Burrs

always go together and as there's not the slightest suggestion of a "chestnut" about the

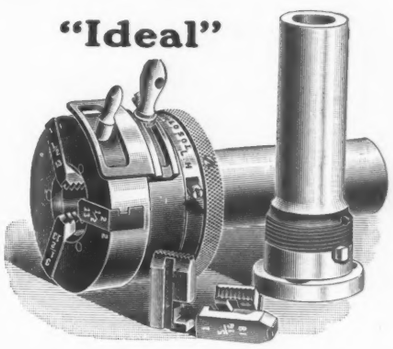
Ideal Opening Die

so there is not the smallest sign of a burr on the thread it cuts. It's self opening too, and without the use of springs The rotation of the work opens the die promptly and positively. The book explains. Get it and see how ideal the "Ideal" is.

Ideal Opening Die Co., 26 West St. New York.

South British Trading Company, Ltd., direct representatives, London, E. C.

"Ideal"



The Rogers & Hubbard Co.

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Middletown Connecticut, U.S.A.

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must often be accomplished in such close quarters that ordinary die stocks could not be operated, but our

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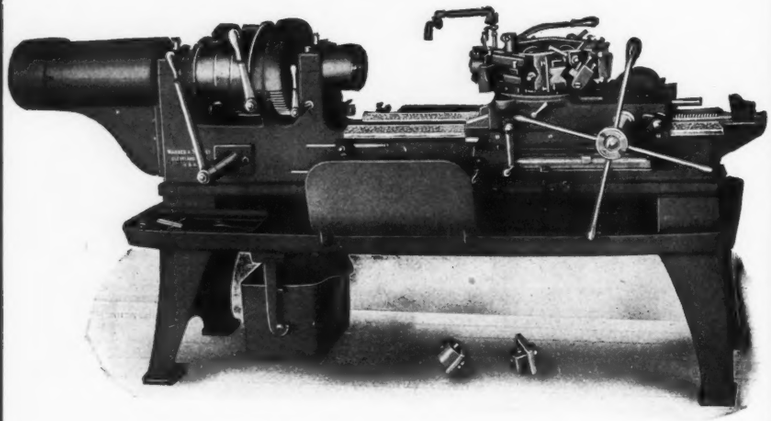

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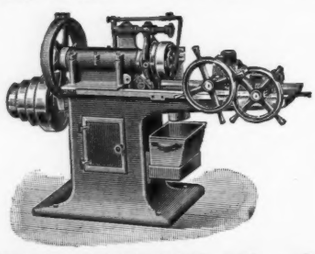
Bolt Threaders, Headers and Nut Tappers.

Write to us for anything you want in this line.



EUROPEAN AGENTS:
Schuchardt & Schutte, Berlin and Vienna.
Adolphe Janssens, Paris.
C. W. Burton, Griffiths & Co. London.

THE ACME MACHINERY COMPANY, Cleveland, Ohio, U. S. A.
Office, 1125 Hamilton Street.

Classified Index to Advts. (Continued).

Gear Patterns.
Garry Iron & Steel Co., Cleveland, O.
Gear Planer, Bevel.
Gleason Tool Co., Rochester, N. Y.
Gear Shapers.
Fellows Gear Shaper Co., Springfield, Vt.
Graduating Machines.
R. K. Le Blond Mch. Tool Co., Cincinnati, O.
Graphite.
Jos. Dixon Crucible Co., Jersey City, N. J.
S. Obermayer Co., Cincinnati, O.
Grinding Machinery.
Anchor Mch. Works, Grand Rapids, Mich.
Bayldon Mch. & Tool Co., Jersey City, N. J.
C. H. Besly & Co., Chicago, Ill.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Builders' Iron Foundry, Providence, R. I.
Carver Cotton Gin Co., East Bridgewater, Mass.
Diamond Mch. Co., Providence, R. I.
Garvin Mch. Co., New York.
Gould & Eberhardt, Newark, N. J.
Geo. Gorton Mch. Co., Racine, Wis.
Grant Mfg. & Mch. Co., Bridgeport, Conn.
Hisey-Wolf Mch. Co., Cincinnati, O.
Landis Tool Co., Waynesboro, Pa.
Loop-Lock Mch. Co., Waltham, Mass.
Modern Tool Co., Erie, Pa.
Norton Emery Wheel Co., Worcester, Mass.
Norton Grinding Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Safety Emery Wheel Co., Springfield, O.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Mfg. Co., Binghamton, N. Y.
Tanite Co., Stroudsburg, Pa.
Tucker Mche. Co., Cincinnati, O.
Whitney Mfg. Co., Hartford, Conn.
Woodward & Rogers Co., Hartford, Conn.
Hammers, Power.
Beaudry & Co., Boston, Mass.
Bement, Miles & Co., New York.
Billings & Spencer Co., Hartford, Conn.
Bradley Co., Syracuse, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Dienelt & Eisenhardt, Philadelphia, Pa.
R. E. Kidder, Worcester, Mass.
Merrill Bros., Brooklyn, N. Y.
Monighan Mche. Wks., Chicago, Ill.
Pratt & Whitney Co., Hartford, Conn.
Scranton & Co., New Haven, Conn.
Waterbury Farrel Fdy. & Mch. Co., Waterbury, Conn.
Handles, Machine Tool.
Norwood Mach. & Mfg. Co., Cincinnati, O.
Hardening and Tempering.
American Gas Furnace Co., New York.
Bennett Tempering Co., New Britain, Conn.
Chicago Flexible Shaft Co., Chicago, Ill.
Coes Wrench Co., Worcester, Mass.
Heading, Upsetting and Forging Machines.
Acme Machinery Co., Cleveland, O.
Heating Machines.
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Heaters.
American Blower Co., Detroit, Mich.
B. F. Sturtevant Co., Jamaica Plain, Mass.
Heaters and Purifiers.
Stewart Heater Co., Buffalo, N. Y.
Hoists.
Garry Iron & Steel Co., Cleveland, O.
Volney W. Mason & Co., Providence, R. I.
Hoists, Pneumatic.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Pawling & Harnischfeger, Milwaukee, Wis.
Rand Drill Co., New York.
Stow Flexible Shaft Co., Philadelphia, Pa.
Hoists, Traveling and Electric.
Pawling & Harnischfeger, Milwaukee, Wis.
Hydraulic Machinery.
Chambersburg Engineering Co., Chambersburg, Pa.
Garry Iron & Steel Co., Cleveland, O.
Waterbury Farrel Fdy. & Mch. Co., Waterbury, Conn.
Watson-St'llman Co., New York.
Hydraulic Tools.
Diamond Drill & Mch. Co., Birdsboro, Pa.
Watson, Stillman Co., New York.
Indicators.
L. S. Starrett Co., Athol, Mass.
R. Woodman Mfg. & Supply Co., Boston, Mass.
Injectors.
Jenkins Bros., New York.
Lunkenheimer Co., Cincinnati, O.
Ohio Injector Co., Wadsworth, O.
Insurance.
Hartford Steam Boiler Insp. & Ins. Co., Hartford, Conn.
Interchangeable Tool Posts.
Bayldon Mch. & Tool Co., Jersey City, N. J.
Jacks.
Dienelt & Eisenhardt, Philadelphia, Pa.
Garry Iron & Steel Co., Cleveland, O.
Watson-Stillman Co., New York.
Key-Seaters.
Baker Bros., Toledo, O.
John T. Burr & Son, Brooklyn, N. Y.
W. P. Davis Mch. Co., Rochester, N. Y.
Mitts & Merrill, Saginaw, Mich.
Morton Mfg. Co., Muskegon Heights, Mich.
National Mch. Tool Co., Cincinnati, O.
Lathes.
American Tool Works Co., Cincinnati, O.
Am. Turret Lathe Mfg. Co., Warren, Pa.
Automatic Mch. Co., Bridgeport, Conn.
Baird Mchy. Co., Pittsburg, Pa.
Wm. Barker & Co., Cincinnati, O.
W. F. & J. Barnes Co., Rockford, Ill.
P. Blaisdell & Co., Worcester, Mass.
J. G. Blount & Co., Everett, Mass.
Bradford Mch. Tool Co., Cincinnati, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Bullard Mch. Tool Co., Bridgeport, Conn.

For Alphabetical Index, see Page 24.

Classified Index to Advts. (Continued).

W. P. Davis Mch. Co., Rochester, N. Y.
Detrick & Harvey Mch. Co., Baltimore, Md.
Faneuil Watch Tool Co., Brighton, Mass.
Fay & Scott, Dexter, Me.
Fenn-Sadler Mch. Co., Hartford, Conn.
Flather & Co., Nashua, N. H.
Gisholt Mch. Co., Madison, Wis.
Goddard Mche. Co., Holyoke, Mass.
Gould & Eberhardt, Newark, N. J.
Greaves, Klusman & Co., Cincinnati, O.
Hamilton Mch. Tool Co., Hamilton, O.
Hendey Mch. Co., Torrington, Conn.
Jones & Lamson Mch. Co., Springfield, Vt.
R. K. Le Blond Mch. Tool Co., Cincinnati, O.
Lodge & Shipley Mch. Tool Co., Cincinnati, O.
Loop-Lock Mch. Co., Waltham, Mass.
McCabe, J. J., New York.
Milwaukee Mch. Tool Co., Milwaukee, Wis.
New Haven Mfg. Co., New Haven, Conn.
Pond Mch. Tool Co., New York.
Potter & Johnston Mche. Co., Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
F. E. Reed Co., Worcester, Mass.
Schumacher & Boye, Cincinnati, O.
Sebastian Lathe Co., Cincinnati, O.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Springfield Mch. Tool Co., Springfield, O.
George D. Walcott & Son, Jackson, Mich.
Warner & Swasey Co., Cleveland, O.
Windsor Mch. Co., Windsor, Vt.
W. C. Young Mfg. Co., Worcester, Mass.

Lathe Attachments.
Bayldon Mch. & Tool Co., Jersey City, N. J.
Flather & Co., Nashua, N. H.

Lathe Feeds.
National Mch. Tool Co., Cincinnati, O.

Lathe and Planer Tools.
Armstrong Bros. Tool Co., Chicago, Ill.
Fairbanks Mche. Tool Co., Springfield, O.
Hill Tool Co., Anderson, Ind.
R. K. Le Blond Mch. Tool Co., Cincinnati, O.
C. P. Mingst, Evansville, Ind.
Pratt & Whitney Co., Hartford, Conn.
Western Mfg. Co., Springfield, O.

Lockers.
Merritt & Co., Philadelphia, Pa.
Narragansett Mche. Co., Providence, R. I.

Lubricants.
C. H. Besly & Co., Chicago, Ill.
Jos. Dixon Crucible Co., Jersey City, N. J.

Lubricators.
Detroit Lubricator Co., Detroit, Mich.
Lunkenheimer Co., Cincinnati, O.

Machine Keys.
Olney & Warrin, New York.
Standard Gauge Steel Co., Beaver Falls, Pa.

Machinery Builders.
Trump Bros. Mch. Co., Wilmington, Del.

Machinery Dealers.
George E. Affleck, New York.
Bourse, The, Philadelphia, Pa.
Chicago Mch. Tool Co., Chicago, Ill.
Foreign.
Garvin Mch. Co., New York.
Girard Mch. & Tool Co., Philadelphia, Pa.
J. J. McCabe, New York.
Prentiss Tool & Supply Co., New York.
C. C. Wormer Mchy. Co., Detroit, Mich.

Machinists' Small Tools.
Athol Mch. Co., Athol, Mass.
C. H. Besly & Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
T. L. Dickinson, New York.
Fenn-Sadler Mch. Co., Hartford, Conn.
Lufkin Rule Co., Saginaw, Mich.
Pratt & Whitney Co., Hartford, Conn.
John M. Rogers B., G. & D. Works, Gloucester City, N. J.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
J. T. Slocomb Co., Providence, R. I.
E. G. Smith, Columbia, Pa.
Standard Tool Co., Cleveland, O.
L. S. Starrett Co., Athol, Mass.
Syracuse Twist Drill Co., Syracuse, N. Y.
J. H. Williams & Co., Brooklyn, N. Y.
J. Wyke & Co., Boston, Mass.

Machinists' Supplies.
Baird Mach'y Co., Pittsburg, Pa.
C. H. Besly & Co., Chicago, Ill.
Pratt & Whitney Co., Hartford, Conn.

Mandrels.
Cleveland Twist Drill Co., Cleveland, O.
W. H. Nicholson & Co., Wilkesbarre, Pa.

Manheads (pressed steel).
Glasgow Iron Co., Pottstown, Pa.

Mechanical Draft.
American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
B. F. Sturtevant Co., Jamaica Plain, Mass.

Metal Polish.
Hoffman, Geo. W., Indianapolis, Ind.
National Tool & Stamping Co., Philadelphia, Pa.

Milling Machines.
The Adams Co., Dubuque, Ia.
Aurora Tool Works, Aurora, Ind.
Beaman & Smith Co., Providence, R. I.
Becker-Brainard Milling Mch. Co., Hyde Park, Mass.
Bement, Miles & Co., New York.
Carter & Hakes Mch. Co., Winsted, Conn.
Cincinnati Milling Mch. Co., Cincinnati, O.
Cleveland Mch. Screw Co., Cleveland, O.
R. M. Clough, Tolland, Conn.
Dwight Slate Mch. Co., Hartford, Conn.
Fox Mch. Co., Grand Rapids, Mich.
Garvin Mch. Co., New York.
Hendey Mch. Co., Torrington, Conn.
Ingersoll Milling Mch. Co., Rockford, Ill.
Kempsmith Mfg. Co., Milwaukee, Wis.
Keystone Mche. Tool Co., Philadelphia, Pa.
R. K. Le Blond Mch. Tool Co., Cincinnati, O.
Loop-Lock Mch. Co., Waltham, Mass.
Newton Mch. Tool Wks., Philadelphia, Pa.

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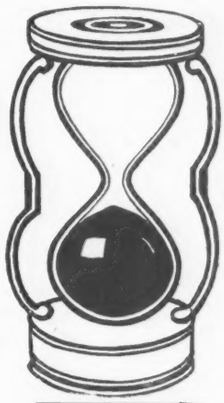
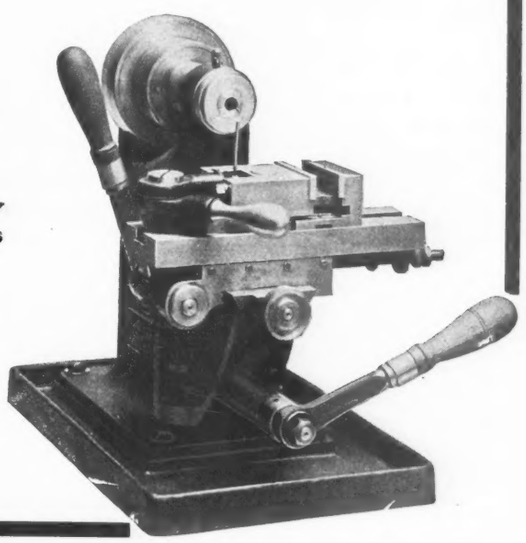
650
Small Parts
Milled
in
One Hour



Six Thousand Five Hundred in One Day

By a Boy
on our
Bench Miller
Good for the Boy

How about using such a machine for sewing machines, typewriters and electrical supply parts. You furnish the boy, we'll supply the machine for $110 F. O. B. New York, Boston or Chicago.



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Locomotive Tires, Car Wheels, Shafting, Etc.
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GRAND PRIX, PARIS, 1900.

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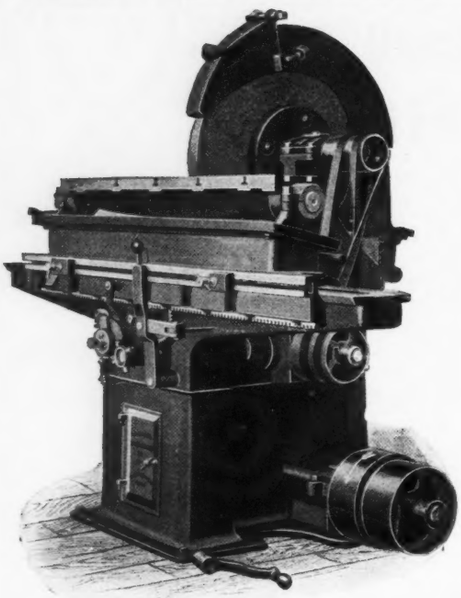

New Improved Automatic

Will grind planing, paper-cutting and other knives requiring an absolutely straight and true edge. It can be used for either wet or dry grinding. The feed can be set to grind as fast or fine as may be desired. Provision is made for compensating for reduction in size of wheel after long use.

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Net, - - - 1,875 lbs.

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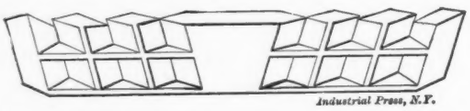

Industrial Press, N.Y.

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We sell these tools for $1.00 each, or $10.00 a dozen.

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Classified Index to Advts. (Continued).

Pratt & Whitney Co., Hartford, Conn.
Waltham Watch Tool Co., Springfield, Mass.
Whitney Mfg. Co., Hartford, Conn.

Milling Cutters.
Becker-Brainard Milling Mch. Co., Hyde Park, Mass.
Boston Gear Wks., Boston, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
R. M. Clough, Tolland, Conn.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Pratt & Whitney, Hartford, Conn.
Reliance Mch. & Tool Co., Cleveland, O.
Standard Tool Co., Cleveland, O.
L. S. Starrett Co., Athol, Mass.

Milling Tools (Hollow Adjustable).
Geometric Drill Co., New Haven, Conn.

Molding Machines.
American Foundry & Mch. Co., Hanover, Pa.
S. Obermayer Co., Cincinnati, O.
Tabor Mfg. Co., Philadelphia, Pa.

Motors.
Giant Motor Co., Elizabeth, N. J.
Steffy Mfg. Co., Philadelphia, Pa.

Motors (Electric).
Crocker-Wheeler Co., Ampere, N. J.
Eck Dynamo & Motor Wks., Belleville, N. J.
Guarantee Electric Co., Chicago, Ill.
Northern Electrical Mfg. Co., Madison, Wis.
B. F. Sturtevant Co., Jamaica Plain, Mass.

Name Plates.
Murdock Corporation, Boston, Mass.
Turner Brass Wks., Chicago, Ill.

Nozzles.
McCullough-Dalzell Crucible Co., Pittsburg, Pa.

Nut Tappers.
Acme Mach'y Co., Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.

Oil Cups.
Bay State Stamping Co., Worcester, Mass.
C. H. Besly & Co., Chicago, Ill.
Detroit Lubricator Co., Detroit, Mich.
Reed Mfg. Co., Erie, Pa.

Oil-Hole Covers.
Bay State Stamping Co., Worcester, Mass.
W. W. & C. F. Tucker, Hartford, Conn.
Winkley Co., Hartford, Conn.

Oilless Bearings.
Arguto Oilless Bearing Co., Philadelphia, Pa.

Packing.
Jenkins Bros., New York.
Peerless Rubber Mfg. Co., New York.

Patterns, Wood and Metal.
Chicago Pattern Wks., Chicago, Ill.
Hartford Pattern & Model Wks., Hartford, Conn.
Platt, O. S., Bridgeport, Conn.

Pattern Letters.
Butler, A. G., New York.

Patents.
Baldwin, Davidson & Wight, New York.
Orlan Clyde Cullen, Washington, D. C.
Howson & Howson, Philadelphia, Pa.
R. J. Jacker, Chicago, Ill.
King, F. H., Chicago, Ill.
E. B. Stocking, Washington, D. C.
Straley, Hasbrouck & Schloeder, New York.
Whittlesey, Geo. P., Washington, D. C.

Pattern-makers' Supplies.
R. E. Kidder, Worcester, Mass.

Phosphorizers.
McCullough-Dalzell Crucible Co., Pittsburg, Pa.

Pipe-Cutting and Threading Tools.
Armstrong Mfg. Co., Bridgeport, Conn.
Columbus Mch. Co., Columbus, O.
Curtis & Curtis Co., Bridgeport, Conn.
Eaton, Cole & Burnham Co., New York.
Hart Mfg. Co., Cleveland, O.
Merrell Mfg. Co., Toledo, O.
Oster Mfg. Co., Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.
D. Saunders' Sons, Yonkers, N. Y.
Trimont Mfg. Co., Roxbury, Mass.
Walworth Mfg. Co., Boston, Mass.

Planers.
E. E. Bartlett, Boston, Mass.
Betts Mch. Co., Wilmington, Del.
P. Blaisdell & Co., Worcester, Mass.
Cincinnati Planer Co., Cincinnati, O.
Detrick & Harvey Mch. Co., Baltimore, Md.
Garvin Mch. Co., New York.
Gleason Tool Co., Rochester, N. Y.
G. A. Gray Co., Cincinnati, O.
Keystone Mche. Tool Wks., Philadelphia, Pa.
Morton Mfg. Co., Muskegon Heights, Mich.
New Haven Mfg. Co., New Haven, Conn.
Pond Mch. Tool Co., New York.
Pratt & Whitney Co., Hartford, Conn.
W. A. Wilson Mch. Co., Rochester, N. Y.
Whitcomb Mfg. Co., Worcester, Mass.
Woodward & Powell Planer Co., Worcester, Mass.

Plumbago.
S. Obermayer Co., Cincinnati, O.

Pneumatic Tools.
Cleveland Pneumatic Tool Co., Cleveland, O.
General Pneu. Tool Co., Montour Falls, N. Y.
Manning, Maxwell & Moore, New York.
Philadelphia Pneu. Tool Co., Philadelphia, Pa.
Railway Appliances Co., Chicago, Ill.
Rand Drill Co., New York.

Presses.
E. E. Bartlett, Boston, Mass.
Billings & Spencer Co., Hartford, Conn.
Falkenau-Sinclair Mch. Co., Philadelphia, Pa.
Hamilton Mch. Tool Co., Hamilton, O.
Hoefer Mfg. Co., Freeport, Ill.
Lucas Mch. Tool Co., Cleveland, O.
Miner & Peck Mfg. Co., New Haven, Conn.
Springfield Mch. Tool Co., Springfield, O.
Torrington Mfg. Co., Torrington, Conn.
Waterbury Farrel Fdy. & Mch. Co., Waterbury, Conn.
Watson-Stillman Co., New York.

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Pulley Blocks.
Yale & Towne Mfg. Co., New York.
Pulleys.
Federal Mfg. Co., Cleveland, O.
Howard Iron Works, Buffalo, N. Y.
Oneida Steel Pulley Co., Oneida, N. Y.
Poole, R., & Son Co., Baltimore, Md.
Saginaw Mfg. Co., Saginaw, Mich.
Pumps.
Watson-Stillman Co., New York.
Punches and Dies.
National Tool & Stamping Co., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
I. P. Richards, Providence, R. I.
Watson-Stillman, New York.
W. C. Young Mfg. Co., Worcester, Mass.
Punching and Shearing Machinery.
Buffalo Forge Co., Buffalo, N. Y.
R. E. Kidder, Worcester, Mass.
Long & Allstatter Co., Hamilton, O.
New Doty Mfg. Co., Janesville, Wis.
Pond Mch. Tool Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Royersford Foundry & Mch. Co., Royersford, Pa.
Watosn-Stillman Co., New York.
W. C. Young Mfg. Co., Worcester, Mass.
Rapping Plates.
Milwaukee Fdy. Supply Co., Milwaukee, Wis.
Reamers.
Cleveland Twist Drill Co., Cleveland, O.
Etna Mfg. Co., New York.
Mergenthaler, Ott Co., Baltimore, Md.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Reed Mfg. Co., Erie, Pa.
John M. Rogers Boat, Gauge & Drill Works, Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Reamers, Pneumatic.
Philadelphia Pneu. Tool Co., Philadelphia, Pa.
Stow Flexible Shaft Co., Philadelphia, Pa.
Riveters.
Chambersburg Engineering Co., Chambersburg, Pa.
Ingersoll-Sergeant Drill Co., New York.
Manning, Maxwell & Moore, New York.
Philadelphia Pneu. Tool Co., Philadelphia, Pa.
Rand Drill Co., New York.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
F. B. Shuster Co., New Haven, Conn.
Roofing Iron.
Garry Iron & Steel Co., Cleveland, O.
Roller Bearings.
Ball Bearing Co., Philadelphia, Pa.
Bantam Mfg. Co., Bantam, Conn.
Standard Roller Bearing Co., Philadelphia, Pa.
Saws.
Diamond Saw & Stamping Wks., Buffalo, N. Y.
Goodell-Pratt Co., Greenfield, Mass.
Millers Falls Co., New York.
Resek Machine Tool Co., Cleveland, O.
H. T. Story, Chicago, Ill.
West Haven Mfg. Co., New Haven, Conn.
Saw Blades.
Diamond Saw & Stamping Wks., Buffalo, N. Y.
Goodell-Pratt Co., Greenfield, Mass.
Millers Falls Co., New York.
West Haven Mfg. Co., New Haven, Conn.
Saw Tables.
Hazelton & Donald, Philadelphia, Pa.
Schools.
Consolidated Schools, New York.
The International Corr. Schools, Scranton, Pa.
Pratt Institute, Brooklyn, N. Y.
Screw Machines.
Asa S. Cook Co., Hartford, Conn.
Jas D. Mattison, New York.
Pratt & Whitney Co., Hartford, Conn.
Warner & Swasey Co., Cleveland, O.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Separators, Oil.
National Separator & Mche. Co., Manchester, N. H.
Shaft Coupler.
Davis, W. P., Mch. Co., Rochester, N. Y.
Shafts, Flexible.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Mfg. Co., Binghamton, N. Y.
Shapers.
Wm. Barker & Co., Cincinnati, O.
Cincinnati Shaper Co., Cincinnati, O.
Flather & Co., Nashua, N. H.
Fox Mch. Co., Grand Rapids, Mich.
Garvin Mch. Co., New York.
Gould & Eberhardt, Newark, N. J.
Hendey Mch. Co., Torrington, Conn.
Kelly, R. A., Co., Xenia, O.
Morton Mfg. Co., Muskegon Heights, Mich.
New Haven Mfg. Co., New Haven, Conn.
Potter & Johnston Mch. Co., Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Conn.
Smith & Mills, Cincinnati, O.
Springfield Mch. Tool Co., Springfield, O.
John Steptoe Shaper Co., Cincinnati, O.
Stockbridge Mch. Co., Worcester, Mass.
George D. Walcott & Son, Jackson, Mich.
Shop Pans.
Kilbourne & Jacobs Mfg. Co., Columbus, O.
Lyon Metallic Mfg. Co., New Haven, Conn.
Slotting Machines.
Betts Mch. Co., Wilmington, Del.
R. M. Clough, Tolland, Conn.
Keystone Mche. Tool Wks., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Special Machinery.
American Foundry & Mch. Co., Hanover, Pa.
Beaman & Smith Co., Providence, R. I.
Detrick & Harvey Mch. Co., Baltimore, Md.
Eclipse Mche. Co., Cleveland, O.
Fenn-Sadler Mch. Co., Hartford, Conn.
Hoefer Mfg. Co., Freeport, Ill.
Keystone Mche. Tool Wks., Philadelphia, Pa.
National Automatic Tool Co., Dayton, O.
Poole, R., & Son Co., Baltimore, Md.

For Alphabetical Index, see Page 24.

The Fosdick Radial Drills

For Full Service

We build the most complete line of Radial Drills in the world, and think we can safely say that they give universal satisfaction. They are simple in design, easy to operate, yet sufficiently strong and rigid to insure accurate work. Belt or motor driven.

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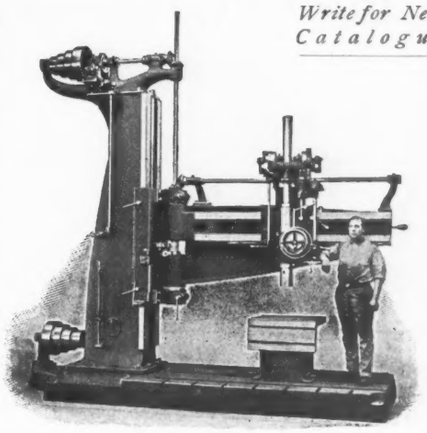

Plain Machines, 2½, 3, 4, 5, 6, 7 and 8 ft. arms.

Half and Full Universal Machines, 5 and 6 ft. arms.

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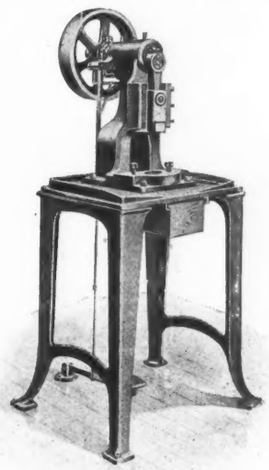

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It is made in two sizes either on table or for bench.

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If so, send for Illustrated Circular to

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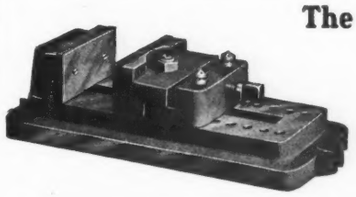

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is the latest and best device for holding work in the upright drill and is built especially for that purpose Convenient to handle, quickly adjusted. Saves time and drills. May we send you circular?

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SUPERIOR TEMPERED FILES.
Save your OLD FILES and have them re-cut equal to new. Let us quote you prices

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against breakage. The steel chasers of Q & E dies are set at an angle that long experience has proved to be the correct position for free and easy thread cutting. The material and workmanship going into our dies are of the highest grade and they produce the most perfect threads with the least effort of any die on the market.

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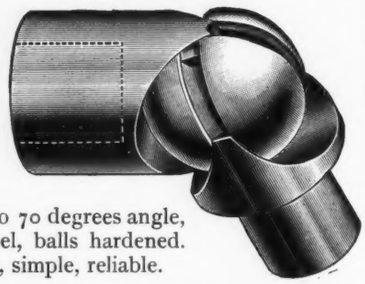
Are in daily use and giving universal satisfaction.



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Hartford, Conn.

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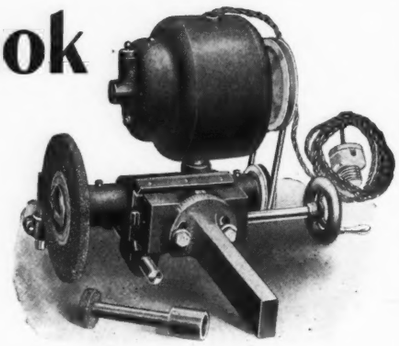

will interest you, if you are looking for economical methods of production.

STYLE No. 10

is the handiest little tool ever made. It will keep your reamers and milling cutters in condition to do accurate work, and lots of it.

It will do your internal and cylindrical grinding jobs of every description.

It will put money in your pocket, besides saving lots of trouble and bother.

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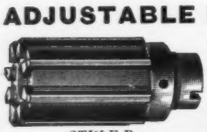

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The construction of this Reamer is such that it is necessary to grind only when dull. There is no uneven clamping with screws, nuts or any other device. Adjustment made quickly and accurately. Send for Catalogue Small Tools.

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Soft Crucible Steel Castings

Extra tough – will bend before breaking. Can be forged, welded, case hardened. Hard tool steel

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25 Per Cent on August Orders.

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Waterbury Farrel Fdy. & Mche. Co., Waterbury, Conn.
W. A. Wilson Mch. Co., Rochester, N. Y.

Speed Changing Device.
Evans, G. F., Boston, Mass.
Garry Iron & Steel Co., Cleveland, O.
Moore & White Co., Philadelphia, Pa.
Reeves Pulley Co., Columbus, Ind.

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Schwerdtle Stamp Co., Bridgeport, Conn.

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Diamond Drill & Mch. Co., Birdsboro, Pa.
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Steel Construction.
Berlin Construction Co., Berlin, Conn.

Steel Rules.
Keuffel & Esser Co., New York.
Lufkin Rule Co., Saginaw, Mich.

Stoppers.
McCullough-Dalzell Crucible Co., Pittsburg, Pa.

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C. H. Besly & Co., Chicago, Ill.
Butterfield & Co., Derby Line, Vt.
S. W. Card Mfg. Co., Mansfield, Mass.
J. M. Carpenter Tap & Die Co., Pawtucket, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Eaton, Cole & Burnham Co., New York.
F. A. Errington, New York.
Etna Mfg. Co., New York.
Geometric Drill Co., New Haven, Conn.
Wm. Jessop & Sons, Ltd., New York.
Modern Tool Co., Erie, Pa.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Reed Mfg. Co., Erie, Pa.
Reliance Mch. & Tool Co., Cleveland, O.
Western Tool Co., Lansing, Mich.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Winter Bros., Wrentham, Mass.

Tap-Holders.
Ideal Mche. Co., Hartford, Conn.

Tapping Attachments.
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Beaman & Smith Co., Providence, R. I.
F. A. Errington, New York.
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O. K. Tool Holder Co., Shelton, Conn.
I. P. Richards, Providence, R. I.
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American Turret Lathe Mfg. Co., Warren, Pa.
Fay & Scott, Dexter, Me.
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Jones & Lamson Mch. Co., Springfield, Vt.
Milwaukee Mch. Tool Co., Milwaukee, Wis.
Warner & Swasey Co., Cleveland, O.
Windsor Mch. Co., Windsor, Vt.

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Baush Mch. Tool Co., Springfield, Mass.
Gray & Prior Mch. Co., Hartford, Conn.
Vanderbeek Tool Wks., Hartford, Conn.

Valves.
Crane Co., Chicago, Ill.
Garry Iron & Steel Co., Cleveland, O.
Jenkins Bros., New York.
Lunkenheimer Co., Cincinnati, O.
Walworth Mfg. Co., Boston, Mass.

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Classified Index to Advts. (Continued).

Vises.
Armstrong Mfg. Co., Bridgeport, Conn.
Athol Mche. Co., Athol, Mass.
Carter & Hakes Mch. Co., Winsted, Conn.
Emmert Mfg. Co., Waynesboro, Pa.
Graham Mfg. Co., Providence, R. I.
Hill Tool Co., Anderson, Ind.
Hopkinson Mch. Wks., Springfield, Mass.
Howard Iron Works, Buffalo, N. Y.
Merrill Bros., Brooklyn, N. Y.
Prentiss Vise Co., New York.
Reed Mfg. Co., Erie, Pa.
Vanderbeek Tool Wks., Hartford, Conn.
Walworth Mfg. Co., Boston, Mass.
Wyman & Gordon, Worcester, Mass.

Welding.
Standard Welding Co., Cleveland, O.

Winches.
Yale & Towne Mfg. Co., New York.

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F. B. Shuster Co., New Haven, Conn.
Turner, Vaughn & Taylor Co., Cuyahoga Falls, O.
Waterbury Farrel Fdy. & Mch. Co., Waterbury, Conn.

Wood Boring Machines, Pneumatic.
Rand Drill Co., New York.

Wood Working Machinery.
Fox Mch. Co., Grand Rapids, Mich.
J. M. Marston & Co., Boston, Mass.

Wrenches.
Armstrong Mfg. Co., Bridgeport, Conn.
Billings & Spencer Co., Hartford, Conn.
J. M. Carpenter Tap & Die Co., Pawtucket, R. I.
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Trimont Mfg. Co., Roxbury, Mass.
Walworth Mfg. Co., Boston, Mass.
J. H. Williams & Co., Brooklyn, N. Y.

For Alphabetical Index, see Page 24.

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Of Every Description.
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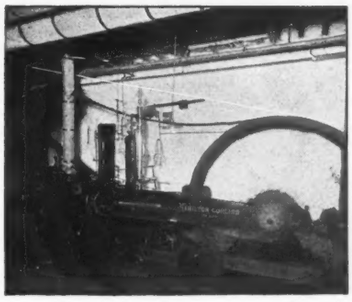

Perhaps you are one of the men who say, "I have tried every thing for my belts and none are of any use, why should I try Cling-Surface?"

There is one reason why you should:

If you stop trying things new to you, you stop advancing.

Where a demand exists something is bound to fill it in time, even though many have failed.

It's so with Cling-Surface. Anyone can claim to do all Cling-Surface does but Cling-Surface shows the proofs in the many photographs of slack belts we print and the letters from large firms who don't usually give letters.

Here is a firm who probably felt as you do, but they tried once more and they won: "On account of our experience with belt dressings we made it a rule not to experiment further. We are, however, obliged to acknowledge our mistake as we find Cling-Surface a very present help in time of trouble."—*Morton E. Converse Co.*, Winchendon, Mass.

We guarantee Cling-Surface to stop all slipping of all belts. Let them be run easy, transmit more power and preserve the belts. It is not sticky—it goes in and preserves.

We send it on approval. Pay only if satisfactory.

Will you try once more?

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***The* Desmond Diamo Carbo Emery Wheel Dresser**

also GRIND STONE TRUER. Superior to a Black Diamond for use where Diamond Dressers are used. A tool room necessity.

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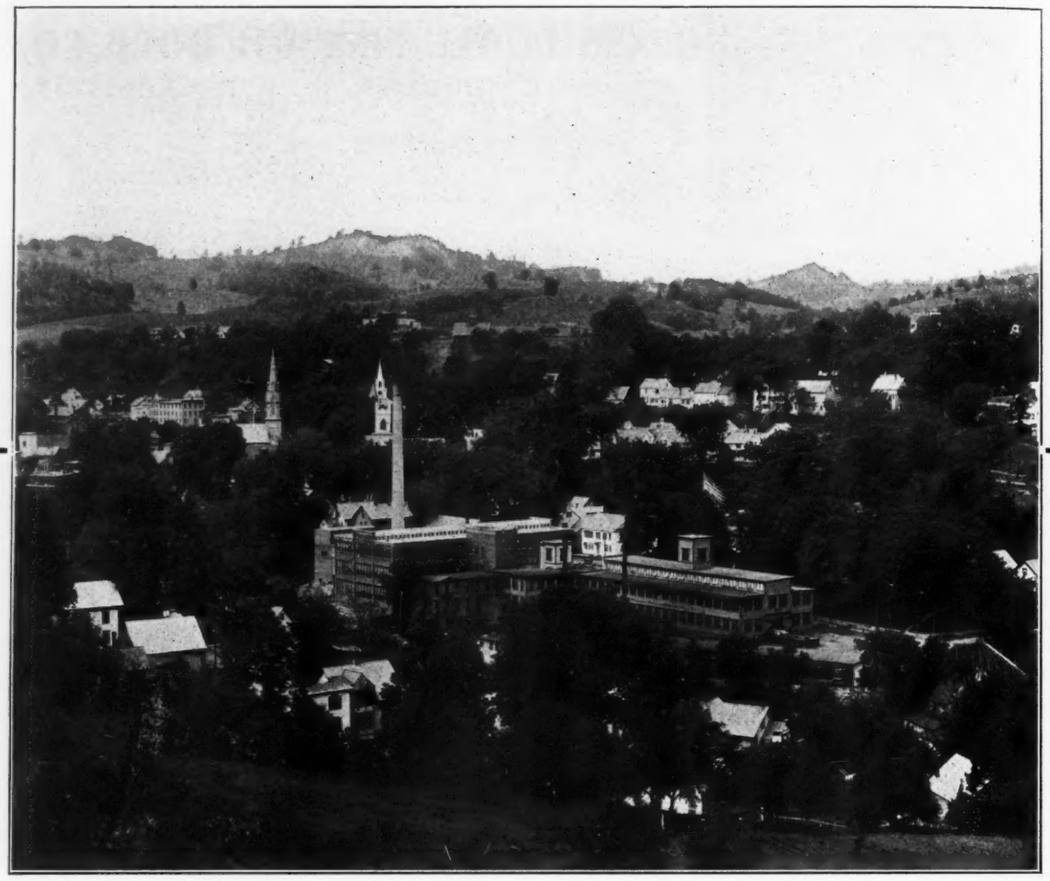

Springfield, Vermont—Jones & Lamson Machine Works in the foreground.

You Need a Rest

No better place to take it than among the New England hills, and in all New England there is no fairer spot than the old Green Mountain State, the home of the Flat Turret Lathe. It is vacation time, but why not combine business with pleasure—stop off at Springfield, Vermont and let us show you where and how the Flat Turret Lathe is made. You will find a thrifty, well kept village in the very midst of those attractions that satisfy the vacation instinct, and our machine shop with its up-to-date equipment and capable, contented mechanics will appeal to the business side. Look into our methods of construction; they cannot fail to interest you and will convince you that we believe in our own products and use the Flat Turret Lathe to the advantage both of ourselves and of those who buy our machines.

A good time, too, to let us estimate what we can save on your lathe work for next year.

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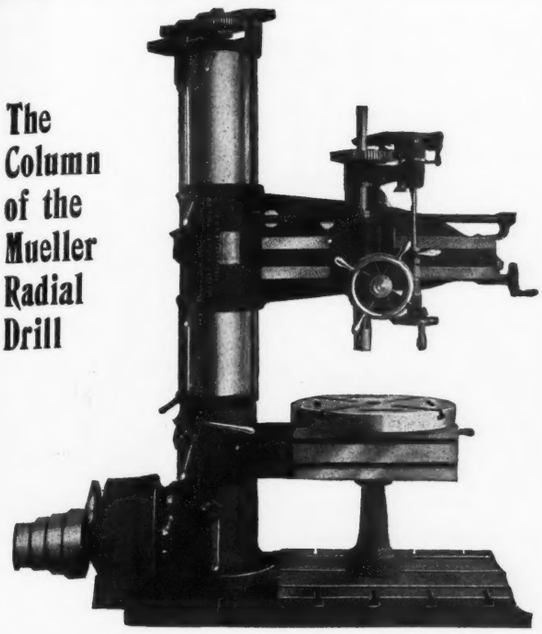
The Column of the Mueller Radial Drill



is stationary and screwed to a heavy ribbed base, thus insuring the utmost rigidity for the arm and work spindle. The arm is supported by a top cap resting on steel balls and revolves with ease; a lever at base of column gives the operator instant control of 16 spindle speeds. Before you buy a radial let us tell you a few more good points of this one.

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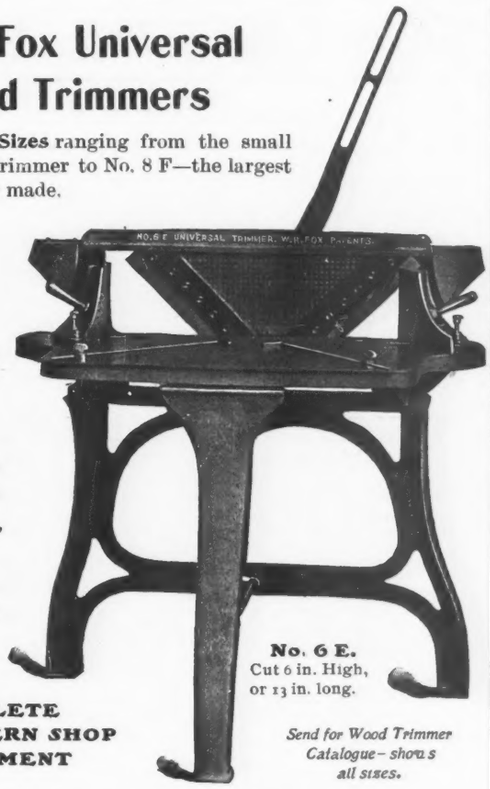
Ten Sizes ranging from the small Bench Trimmer to No. 8 F—the largest Trimmer made.



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No. 6 E.
Cut 6 in. High, or 13 in. long.

COMPLETE PATTERN SHOP EQUIPMENT

Send for Wood Trimmer Catalogue—shows all sizes.

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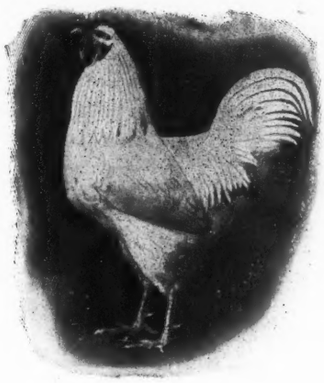

"I luv a rooster for tew things—one is the krow that is in him, and the other is the spurs that air on him to back up his krow with."—*Josh Billings.*

BANTAM MFG. COMPANY

W. S. ROGERS, General Manager

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Drop Forged Through-out.

Every Shop Should Have it

Three sizes—10″, 14″, 18″. Semi and Full Finished.

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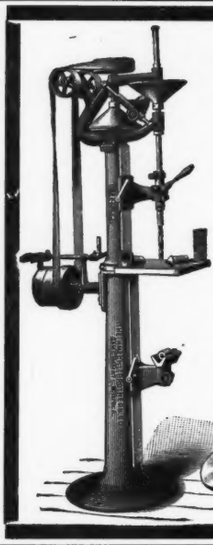
The Pioneer Drop Forgers of America. HARTFORD, CONN., U. S. A.



When Speed and Power are Right, the Drills Don't Break.

The saving in drills alone, therefore, will more than pay for the installation of the **Knecht Sensitive Friction Drill,** and the many other advantages will be clear gain. Don't you think it would pay you to investigate? Our book is ready.

The **Knecht Bros. Co.**
Beekman and Knox Streets,
CINCINNATI, O.

A PLEASING FEATURE

Of the **"Cincinnati" Upright** is its ability to turn drill work into profits of some account. Not just merely profits, but fine large ones that are worth while.
No one ever sets the **"Cincinnati"** into the back shop, or asks what the second-hand man will give. The **"Cincinnati"** goes in and stays in, and all the time it's in it's making money for for the owner.
The **"Cincinnati"** is built to these pleasing ends.
The patented tapping attachment is one of the reasons, others in the book—on request.

Cincinnati Machine Tool Company
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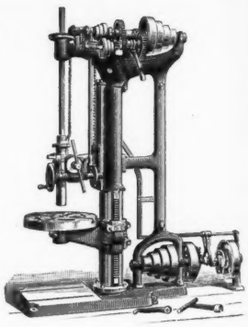

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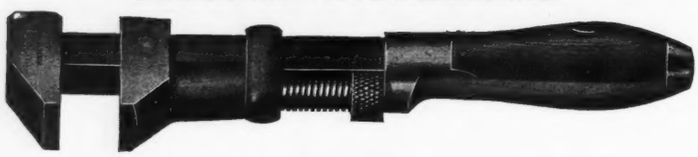

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ROCHESTER, NEW YORK.

THE WATERBURY FARREL FOUNDRY and MACHINE CO. Waterbury, Conn., U.S.A.

DESIGNERS AND BUILDERS OF SPECIAL MACHINERY DESCRIBED IN CATALOGS.

A=Automatic Rivet Machines.
B=Hinge and Butt Machines.
C=Cartridge Machines.
E=Drop, Screw and Foot Presses.
G=Tube and Rod Drawing Machinery.
H=Hydraulic Machinery.
L=Spinning Lathes, Edging Lathes, etc.
M=Open Back, Single Acting Power Presses.
N=Pillar Single Acting Power Presses.
P=Double Acting Power Presses.
R=Rolling Mills
S=Shears and Slitters.
T=Furnaces, etc.

HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.
HARTFORD, CONN.

J. M. ALLEN, - - - President.
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Brown & Sharpe Mfg. Co.

Providence, R. I., U. S. A.

Mechanical Machinists' Tools

that are

Noted for their Accuracy

and

Quality of Workmanship

It is only by the employment of expert mechanical skill aided by accurate dividing engines and special machines that tools of such ACCURACY as the

"B. & S." Micrometer Caliper

can be produced.

One Thousand

Different Varieties of

MACHINISTS' TOOLS

Regularly carried in stock. The dealers have this to draw from and can furnish at short notice any of the tools listed in Catalogue No. 103, which is mailed to any address upon application.

For Example:

A Micrometer for almost any purpose can be selected from this stock.

100 Different Styles of Micrometers Carried in Stock.
Other Lines of Machinists' Tools Equally Complete.

Station, N. H.: Lisbon, Piermont, and Littleton, N. H.; Evansville, Vt., Manlius, N. Y.; Hot Springs, Ark.; and Orleans, Ind. The New York office is at 151 Chambers Street.

THE STANDARD ROLLER BEARING CO., Forty-eighth and Girard Avenue, Philadelphia, Pa. Catalogue of ball and roller bearings. This illustrates the roller, ball, roller thrust, grooved ball, and propeller roller thrust bearings; also railroad bearings. A long list is given of the large number and variety of machines to which these bearings can be profitably applied. The book is cloth bound, of convenient size, and should prove useful to any one interested.

THE C. W. HUNT CO., West New Brighton, Staten Island, N. Y. Catalogue 035, of coal handling machinery. This facilitates the rapid and economical transportation of coal and ashes to their destination. Industrial railways, electric locomotives, steam and electric hoists, coal tubs and chutes, steam shovels, wheelbarrows, coal crackers, hoppers, etc., and hoisting blocks and wire and manila rope for hoisting purposes are here shown.

THE SAWYER TOOL MFG. CO., Fitchburg, Mass. Illustrated catalogue "F" of fine tools and hardware specialties. This includes various sizes of center gages, straightedges, protractors, combination squares and in fact all the small tools so well known and much employed by the mechanic. The company call attention to the accuracy of these tools and state that *all* their squares are furnished with hardened blades.

THE COCHRANE-BLY MACHINE WORKS, Rochester, N. Y. Pamphlet describing the Cochrane-Bly universal shaper, which has been designed to cover a great variety of work and is adapted to all classes of intricate punch and die work, metal pattern and jig making. The company state that with this machine work may be planed at every possible angle. A half-tone cut of this shaper is shown and also several examples of the work done.

THE FOOS GAS ENGINE CO., Springfield, O. Catalogue No. 12 of gas and gasoline engines. This is 8 x 10½ inches, and full page cuts are given which certainly show the engines to advantage. The Foos "Special" engine appears, for operating on gasoline, naphtha, distillate, etc.; also a portable engine with steel truck; one with wood truck, the Foos traction engine, and an electric engine. The Foos electric igniter, governor, bed casting and crankshaft, inlet and exhaust valves, connecting rods and cams are described in detail.

THE GARBY IRON & STEEL CO., Cleveland, O. Catalogue of pneumatic, electric and hand power cranes. These are built for a great variety of purposes, such as unloading freight or passenger car trucks, loading and piling buffer beams, loading and piling material in factories and store rooms, coaling locomotives, etc. A portable pneumatic plant is also shown, used in contracting work, consisting of a boiler, steam-driven air compressor, air receiver, coal tank, water tank, and arranged on a steel truck to be drawn by horses wherever needed.

THE JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J. Booklet descriptive of Dixon's latest product, the "Eterno" indelible pencil. This writes such a dark purple as to be practically black, and the copy is clear, sharp and indelible. It may be put to many and various uses and combines the convenience of the pencil with the permanence of the pen. A clever little sketch shows some unfortunate specimens of humanity wearily struggling along under the burden of "The Pen" with its uncomfortably dripping load of ink; and another pictures a duel, with swords, between the "Eterno" and "The Pen," in which, of course, the former comes off victorious. We sincerely hope the Recording Angel will not hear of Dixon's "Eterno" *indelible* pencil.

THE INGERSOLL MILLING MACHINE CO., Rockford, Ill. Illustrated catalogue, April, 1903, of heavy milling machines. This is a handsome work of large size, with excellent half-tone engravings of the company's product, which is milling machines exclusively. Following are some of the varieties built: Four-head milling machine, spur driven, and worm-driven; three-head worm-driven milling machine; combined horizontal and vertical milling machine with universal head on rail; single and double vertical milling machine of many sizes; horizontal millers, some plain, some with vertical spindle attachment—in fact, every variety and size that can be required for milling work. A number of page cuts illustrate different examples of intricate milling accomplished by the use of these milling machines.

THE CLEVELAND PNEUMATIC TOOL CO., Cleveland, O. Catalogue E of pneumatic tools. This is handsomely gotten up, is printed on heavy coated paper and contains a large number of fine half-tone engravings. A number of new tools are listed, for chipping, calking, beading, riveting, in addition to the line of tools formerly manufactured. Interesting views show the various tools at work, among them a pneumatic painting machine and a special riveting hammer which is built by this concern to drive drift bolts in crib, dock and marine work. The various sizes and styles of these tools are given and short directions as to the proper care of each tool. Their line of pneumatic riveters is very complete, these tools being made to drive from ⅛ cold to 1½-inch hot rivets.

SCHUMACHER & BOYE, Cincinnati, O. Circular descriptive of their new 18-inch engine lathe. We believe there is no handsomer trade literature than that sent out by Schumacher & Boye, and this circular is a fine example. It is printed on heavy coated paper, and an excellent half-tone of the lathe illustrates the new patented instantaneous change gear device for feeds and screw cutting, a special feature of this new machine. A description of the lathe and specifications are also given. The company will continue the manufacture of their well-known line of standard engine lathes without the instantaneous change gear device. Their new office and warehouse building at Spring Grove Avenue, near their present works, is nearly completed, and they expect that it will be ready for occupancy about the first of September. The building will include a spacious and elegant club room, which will be used by the manufacturers whose works are in their vicinity.

THE NATIONAL-ACME MFG. CO., Cleveland, O. Handsomely illustrated catalogue describing the "Acme" multiple spindle full automatic screw machines, and the semi-automatic screw slotting machines. The title page which is headed "The Spirit of Progress" shows by a series of pictures the evolution of the multiple spindle automatic screw machine. This is followed by a full description of the machine and of its leading features. The chief characteristic of this machine is that all tools act simultaneously, making it practicable to finish a piece with but one set of tools in use, in about the time required for a single operation. The various types and sizes of these machines are shown. A good part of the catalogue is devoted to the illustration of the various tools used on the "Acme" automatic and to fine examples of the work turned out. Typographically, the work presents an exceptionally fine appearance.

MANUFACTURERS' NOTES.

THE BRADFORD MACHINE TOOL CO., Cincinnati, O., manufacturers of engine lathes, are building a two-story addition to their shop, 60 x 100.

THE KEYSTONE DROP FORGE WORKS, formerly located at Philadelphia, have removed to their new works at Chester, Pa., where they have increased facilities.

F. H. BULTMAN & CO., manufacturers of automatic gear cutters, have removed from their former location on 106-108 Canal Street, to more spacious quarters at 35 West Center Street, and 131 Viaduct, Cleveland, O.

THE MILWAUKEE RICE MACHINERY CO., Milwaukee, Wis., report business as having been very good for the past year, and state there is every indication of its continuing so when the quiet period during the hot weather is past.

THE GLACIER METAL CO., New York and London, have established a southern office in Richmond, Va. Their New York office is at 26 Cortlandt Street. They manufacture the "Glacier" anti-friction metal used for high-speed and heavy running machinery.

HORSBURGH & SCOTT, manufacturers of cut gears, Cleveland, O., have incorporated their business under the style of the Horsburgh & Scott Co., and have moved to their new works, 1240 Hamilton Street, that city, where they have additional room for their increased business.

THE COLUMBIA ENGINEERING WORKS, INC., William and Imlay Streets, Brooklyn, N. Y., have taken up the manufacture of the Arthur Herschmann patent steam wagons, and will build 3-ton and 6-ton capacity trucks. An automobile department has been established, equipped with tools specially adapted for the work.

E. & T. FAIRBANKS & CO., St. Johnsbury, Vt., recently decided to adopt a nine-hour day in their scale factory, which took effect on June 1. Since the establishment of this factory 60 years ago, we are told there has never been any strike or labor contest and this last concession was voluntary.

THE CINCINNATI MACHINE TOOL CO., manufacturers of upright drills, are working on the plans for their new shop on the corner of Spring Grove Avenue and Township Street, Cincinnati, near Lodge & Shipley Co.'s. The building will be of brick, three stories high, 60 x 185, with light on three streets, and they expect to get in some time in October.

THE BATES FORGING CO., 410 No. Penn Avenue, Indianapolis, Ind., is a new company organized recently for the manufacture of a drop-forged double flanged wheel. They expect to be in full operation in the early fall, and are busy at the present time equipping their plant with all the necessary new tools. The president of the new company is F. L. Bates, formerly with the Indianapolis Drop Forging Co.; and the secretary and treasurer, John A. Glass.

THE DIAMOND DRILL & MACHINE CO., Birdsboro, Pa., inform us that their iron foundry and new steel plant continue to run night and day and that they are shipping castings in from one to four weeks. Despite their present facilities for turning out work, their modern methods and equipment, they find it necessary to build another open-hearth furnace to accommodate the large and increasing business. Their machine shop also shares in the general prosperity.

THE REEVES PULLEY COMPANY, Columbus, Ind., report two splendid new sales agencies for their well-known "Reeves" wood split pulley—the Niles-Bement-Pond Co., Boston, for the New England territory; and the newly organized American Frog & Mfg. Co., Kansas City, Mo., for Kansas City and tributary territory. For both of these points large and well assorted stocks are now in transit, and the Reeves Company state that both enter the line with every evidence of a large pulley trade.

THE CINCINNATI ELECTRIC MOTOR CO., Cincinnati, O., will be known in future as the Barriett Electric Co. The officers are S. L. Barriett, president and treasurer; E. E. Prothereo, secretary. The new concern will manufacture stationary motors of from ½ horse power to 10 horse power, and are equipped throughout with automatic machinery. Mr. Barriett is well-known in the machinery field, having been master mechanic of the West Point Foundry during the Spanish-American war. He designed special tools and machinery for manufacturing projectiles, also several disappearing gun carriages.

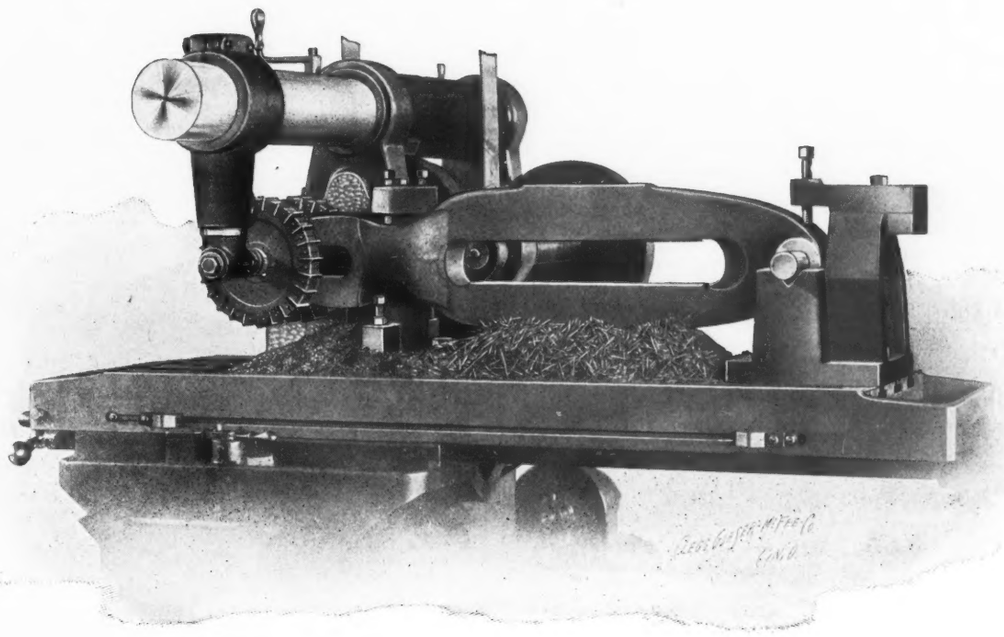
THE DERRY-COLLARD CO., 256 Broadway, New York, inform us that of the first thousand copies of the "American Steel Worker," by E. R. Markham, less than 50 copies remain. We have at hand a booklet issued by this company calling attention to their list of technical books and their method of selling same, which is to send the work for examination, and if it does not prove to be what is desired, it may be returned to the company. Those interested in new technical publications, and in revised editions of old works, should secure one of these booklets.

THE LUNKENHEIMER CO., Cincinnati, O., on July 18, tendered to their employees the annual outing (the forty-first) at Woodsdale Island Park. Seven hundred employees participated this year, with their families, making in all about 2,000 people, including the children. There were music, dancing and refreshments, cost of which was defrayed by the company, as also was the expense of transportation. The trip to Woodsdale Island Park is made on the C., H. & D. R. R., and it required two sections of ten coaches each to carry the passengers.

W. N. DURANT, 231 Twenty-second Street, Milwaukee, Wis., has sent us a celluloid letter opener, always a useful article around a busy man's desk, on which appear a reproduction of the counters he manufactures and his name and business address. In addition to the usual purposes for which these counters have been used in the past, we are informed that Mr. Durant has perfected a method for using them in connection with power presses, thus forming a ready means of keeping account of the work produced without the necessity of manual counting. Since counters suited to this purpose have been placed upon the market they have been adopted by many of the leading builders of power presses as regular attachments to their machines and are reported to be giving much satisfaction.

THE GISHOLT MACHINE CO., Madison, Wis., have recently amended their articles of incorporation, increasing their capital to $750,000. Up to the present time the Gisholt Company confined themselves almost exclusively to the manufacture of the now well-known "Gisholt" lathe. These tools are made in several varieties and sizes, and the line is being constantly extended. The increasing business in "Gisholt" lathes has necessitated a very considerable increase in the manufacturing facilities of the company, and additions have recently been made, both in buildings and equipment, that will double the former capacity of the plant. While the new buildings and equipment will be largely used for producing "Gisholt" lathes, they will, in part, be used for the manufacture of other types of machine tools, such as boring mills, etc. The last-named machines, however, will not be manufactured on a large scale until new buildings now in contemplation are completed. Contracts have recently been made for a large new foundry to be equipped throughout with modern, up-to-date appliances. The building will be strictly fireproof.

THE AMERICAN SCHOOL OF CORRESPONDENCE, Chicago, Ill., was recently tendered a series of receptions by the management of the Armour Institute of Technology, at which Dr. Gunsaulus, president of Armour Institute presided and Mr. William E. Curtis was one of the speakers. We have before us clippings from four leading papers giving interesting accounts of this event, and Mr. Zapf, the secretary of the school, reports that the school is in a most flourishing condition, as thoughtful people are beginning to recognize that correspondence instruction is filling a real need, bringing an education within the reach of thousands whose limited means and time would not allow them to follow a regular college course. All the officers and instructors of the school are college men, graduates from such institutions as the Massachusetts Institute of Technology, Harvard, Tufts College, etc., men fitted by experience and education to offer sound instruction, and whose sense of responsibility to their Alma Mater will not permit them to hold any but the highest educational ideals and standards. We are informed that President Eliot, of Harvard, while recently visiting the school, expressed himself amazed at the scope, thoroughness and standard of its papers, and another evidence of the great advance in the standard of this instruction is the fact that Columbia University and the United States government in the Army Post Schools use the school's instruction papers as textbooks.



How Would You Machine This Job?

It is a rocker arm for a 24″ shaper which the Cincinnati Shaper Company used **to plane, taking 14½ hours to do it. Now they mill them, finishing all over—12 surfaces in all—in 2½ hours on a**

No. 4 Plain Geared Feed Cincinnati Miller

On this page last month was shown the beginning of the job. This month we show its completion. The cutters are 8½″ diameter, and remove nearly ¼″ metal. The sides are faced with a 9½″ face mill. The cut is very heavy. That's where the "Cincinnati Geared-feed" comes in. And then, they find it profitable to change the feed to suit each cut. Our quick feed-changing device does it without loss of time. Any other No. 4 Plain Miller would require a half hour. Don't you think it would pay you to mill some of your work? A good bit depends upon the Miller. We've got a lot of data about work which the "Cincinnati" will do. Better ask for

"Examples of Rapid Milling."

WE ARE MILLING SPECIALISTS.

The Cincinnati Milling Machine Co.,

Cincinnati, Ohio, U. S. A.

EUROPEAN AGENTS—Schuchardt & Schutte, Berlin, Cologne, Vienna, St. Petersburg, Brussels, Stockholm. Adolphe Janssens, Paris. Chas. Churchill & Co., London, Manchester, Newcastle-on-Tyne and Glasgow. Niles-Bement-Pond Co., 23 and 25 Victoria St., London, S. W.

CANADA AGENTS—Williams & Wilson, Montreal. H. W. Petrie, Toronto.

MISCELLANEOUS.

Advertisements in this column, 25 cents a line, ten words to a line.

The money should be sent with the order.

A NEW drill drift; always ready; self-contained; quick acting; no hammer needed; low price. MARIA STEIN MCH. WORKS, Maria Stein, O.

BOOK, "DIES AND DIEMAKING," 100 6x9 pages, $1, post paid; send for index. J. L. LUCAS, Bridgeport, Conn.

DRAFTSMEN desiring occasional extra business in line with drafting; state where regularly employed; confidential. Address EDWIN GUTHRIE, Corcoran Building, Washington, D. C.

EXPERIENCED Brass Workers on Fox lathes. LA FRANCE FIRE ENGINE CO., Elmira, N. Y.

EXPERIENCED mechanical draughtsman wanted. Permanent employment assured to rapid and accurate draughtsman. Address "MILL WORK," care MACHINERY, 66 West Broadway, New York.

INVENTORS.—Do you realize that you may lose your right to obtain a patent on your invention by delaying to apply for it? Information and prices cheerfully given. Correspondence solicited. JAMES N. CATLOW, Lawyer and Registered Patent Attorney, 120 Broadway, New York.

MACHINISTS' 50-PAGE BOOK.—"Pointers and Rules," 25 cents; try it; agents wanted. WM. POWLES, 485 North Street, St. Paul, Minn.

MONARCH STEEL WELDING COMPOUND is not a cheap welding compound, it is made for high grade steel, such as tool steel, cast steel and crucible steel, and welds them solid without loss of time. Send for free sample. W. M. TOY, Sidney, Ohio.

PATENTS.—H. W. T. Jenner, patent attorney and mechanical expert, 608 F Street, Washington, D. C. Established 1883. I make an examination free of charge and report if a patent can be had and exactly how much it will cost. Send for circular. Member of Patent Law Association.

PATENT YOUR ORIGINAL IDEAS.—They may be valuable some day. If in doubt as to patentability, write me, giving sketch and full description, and I will give you my opinion as to patentability free of charge. F. H. KING, Patent Lawyer and Solicitor, 1462 Monadnock Bldg., Chicago, Ill.

TEXTILE MACHINERY.—Engineers having 9 years' technical and practical experience offer their services for the construction and introduction of a larger Textile machine (Embroidery Machine) not yet constructed, in America. Address "D 4046," care Haasenstein & Vogler, A. G., Chemnitz, Saxony.

THE Wellman Sole Cutting Machine Co., of Medford, Mass., designs and builds light machinery. Correspondence solicited.

WANTED, ADDITIONAL WORK.—A large first-class machine shop equipped with all modern and up-to-date tools and now making a standard line of high grade apparatus has additional capacity for making one or more small patented or other articles that can be made and sold in quantities, and would be pleased to get in touch with anyone having such articles to make. B. M. CO., care MACHINERY, 66 W. Broadway, New York.

WANTED.—A few more Gray Iron Castings to make; satisfaction guaranteed both as to price and quality of work. Correspondence solicited. ATHOL MACHINE CO., Athol, Mass.

WE have a position for a capable foreman for drop forging plant; must be a man accustomed to planning work and handling men. In writing give full information as to experience. WYMAN & GORDON, Worcester, Mass.

RESPONSIBLE position desired by capable mechanic, September first. Address Box 55, care MACHINERY, 66 W. Broadway, New York.

WANTED.—All kinds experienced engineers, draftsmen, foremen and superintendents to register; positions open. CLEVELAND ENGINEERING AGENCY, Station G, Cleveland, O.

WANTED.—A machinist in every shop to sell my Calipers and Levels. Liberal proposition. Address E. G. SMITH, Columbia, Pa.

WANTED.—By a practical machinist and marine engineer, position as foreman, master mechanic or superintendent of construction. Contracted and built Rolling Mills, Distillery, Cooperage and Glucose Machinery; also built, tested and set up Marine Engines in steamers. Best of reference. Chicago reference, Robert Tirant Engine & Tool Builder. Address "J. C. F.," care MACHINERY, 66 West Broadway, New York.

WANTED.—Contract and jobbing work on medium and heavyweight machinery. Prompt delivery. U. S. RAPID-FIRE GUN & POWER CO., Derby, Conn.

WANTED.—First-class Tool Room Foreman. Must have good executive ability and knowledge of designing and building tools, gauges and fixtures. Address TOOL ROOM, care MACHINERY, 66 W. Broadway, N. Y.

We are constantly increasing the scope of our work, and invite applications for positions from first-class patternmakers, molders and core-makers. We always have vacancies. Address ALLIS-CHALMERS CO., Lock Box No. 1065, Chicago, Ill.

WE are constantly increasing the scope of our work, and invite applications for positions from first-class patternmakers, molders and machinsists. We always have vacancies. Address THE WESTINGHOUSE MACHINE CO., East Pittsburg, Pa.

WELL ESTABLISHED MACHINE TOOL BUILDER wishes to make arrangement with thoroughly capable man to take charge of the manufacturing end of the business, and invest enough money to give him a personal interest in the concern. Address "G. M. C.," care MACHINERY, 66 West Broadway, New York.

Thirty Day or Sixty Day Trial—

it's all one to us. We are morally sure that however exhaustive the test of the Warden Filter, the result will be the same as expressed in the following letter:—

THE BURT MANUFACTURING CO.,
Akron, Ohio.

Gentlemen:—In reference to your account of March 5th, we beg to say that we bought the No. 1 Oil Filter with the understanding that we were to have 60 days, and if it was satisfactory at the end of that time we would pay you for same within 60 days after completion of test. We are very well pleased with the filter and will send you check for same between the 1st and 20th of next month, which we trust will be entirely satisfactory.

Very truly yours,
COLBURN MACHINE TOOL CO.

If not quite satisfied about your oil bills, let us ship *you* a filter on trial—no expense if it's not all we claim; we guarantee certain things and live up to the guarantee.

Thirty-three Burt Exhaust Heads

are now in use by the Baldwin Locomotive Works—

a pretty good argument as to the efficiency of this money-saving device. The Baldwin people sent us their first order for exhaust heads some time ago—these filled the bill so well that they have gone on buying and we have just filled their 12th order, calling for 12 exhaust heads, making a grand total of 33 in all. Burt Exhaust Heads save expensive repairs, prevent rotted roofs and disfigured buildings, and make the exhaust noiseless. Sizes from 1 inch to 60 inches. Sent on trial.

The Burt Manufacturing Co., Main & Howard Sts., Akron, Ohio, U. S. A.

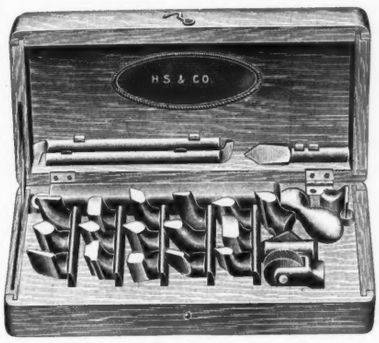
SHELBY & CO., LONDON, E. C., ENG., AGENTS FOR GREAT BRITAIN.

"NOVO" STEEL

The Newest and Greatest Yet

is now used in the bits or "points" comprising the celebrated

"O. K." LATHE TOOLS.



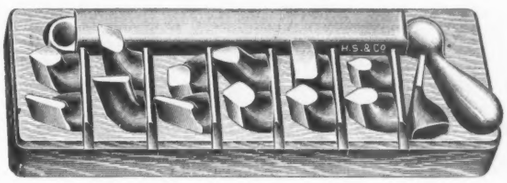
The "O. K." Tool Holder with assorted tools and fixtures possesses peculiar advantages, and advantages that make it especially useful when it is necessary to change tools often. Any of these tools can be removed from the holder and another substituted without disturbing the holder when once placed in position on the lathe or shaper. This change can be made instantaneously, making a time saving of no mean moment. The holder is so constructed as to hold the tools as firmly as though they were a portion of the holder itself, and a quarter turn of the handle serves to release the tool and allow another to be inserted. The shanks are drop forged from the best quality of tool steel and points may be had made of the NOVO steel, by far and away the greatest steel yet invented.

Complete Sets A and B contain one tool each of the following numbers: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, and two of No. 12.

Complete Set C contains one tool each of the following numbers: 5, 6, 7, 9, 10, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, two of No. 1 and 2, and 3 of No. 12.

"O.K." LATHE TOOLS.

WORKING SETS.



Where it is not desired to purchase a complete set at first, working sets, containing carefully selected assortments as follows, may be had:

Working Sets A and B contain one tool each of the following numbers: 1, 5, 6, 7, 8, 9, 13, 14, 17, 20, 21, 22, 27, and two of Nos. 2 and 12.

Working Set C contains one tool each of the following numbers: 1, 5, 7, 9, 13, 14, 17, 20, 21, 22, 27, and two of Nos. 2, 6 and 12.

In ordering, be sure to state whether a complete or working set is wanted.

Description of "O. K." Lathe Tools. Tools can be bought separately if sets are not wanted.

1 Left Side Tool.
2 Right Side Tool, bent.
3 Left Side Brass Tool.
4 Right Side Brass Tool, bent.
5 Left Offset Diamond Point.
6 Right Offset Diamond Point.
7 Right Side Parting Tool, bent.
8 Straight Brass Tool.
9 Left Diamond Point.
10 Straight Roughing Thread Tool.
11 Mushet Diamond Point.
12 Right Diamond Point.
13 Straight Finishing Thread Tool.
14 Right Thread Tool, bent.
15 Female Radius, $\frac{3}{32}$", $\frac{1}{8}$", $\frac{5}{32}$".
16 Male Radius, $\frac{3}{32}$", $\frac{1}{8}$", $\frac{5}{32}$".
17 Flat Nose Tool.
18 Inside Boring Fixture.
19 Knurling Fixture.
20 Drawbolt
21 Handle
22 Holder
23 Spotting Tool.
24 Inside Boring Tool.
25 Inside Threading Tool.
26 Case.
27 Working Set Case.

No lathe man can afford to be without a set of these tools. We are prepared to furnish, from stock, and at prices as low as the lowest. Correspondence invited.

Hammacher, Schlemmer & Company,

New York City, Since 1848.

It's the Spiral Disc and the Spiral Groove that do the Business.

Twice as much work can be done in a day with the Gardner Grinder because the spiral grooved discs, covered with our improved spiral circles, produce a rapid shear cut that leaves the ordinary grinder far behind. It is the ideal method for finishing all flat surfaces and we can adapt the composition of emery on the spiral circles to suit all classes of work, and can duplicate any composition exactly. Send us a sample of your work and let us try it on the Gardner Grinder. We will finish and return it, free of charge, and report exactly what we can save you.

Charles H. Besly & Company,

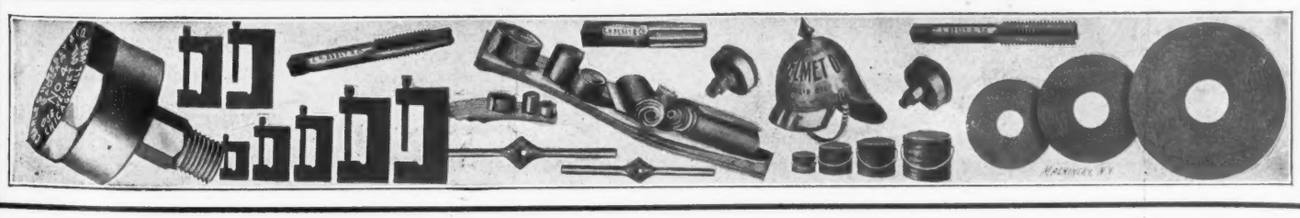
'Rah for the Helmet Temper Taps!

Fifty per cent. more durable than the ordinary kind and the price no higher.

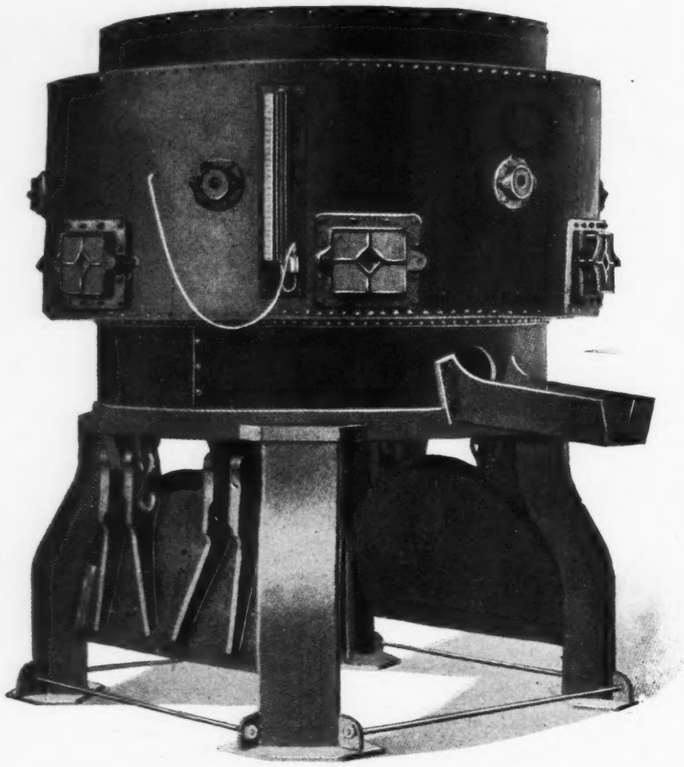
Helmet Temper Taps wear longer and do better work because our process of manufacture makes them tougher and stronger than any others. The flutes are produced by forging and the threads milled on the unannealed stock after forging. No stock is removed except between the threads and the cutting edge is the original tough skin of the bar.

We carry all ordinary sizes and threads in stock, and would like to send you samples for trial. Write us the size.

15 to 21 Clinton Street, Chicago, Ill., U. S. A.



20th Century Foundry Equipment.



The Newten—the 20th Century Cupola.

The Newten Cupola

is correctly designed; a rapid melter, economical in fuel and made better than a cupola was ever made before. What more can a foundryman want? The illustration shows furnace section only; let us send you details.

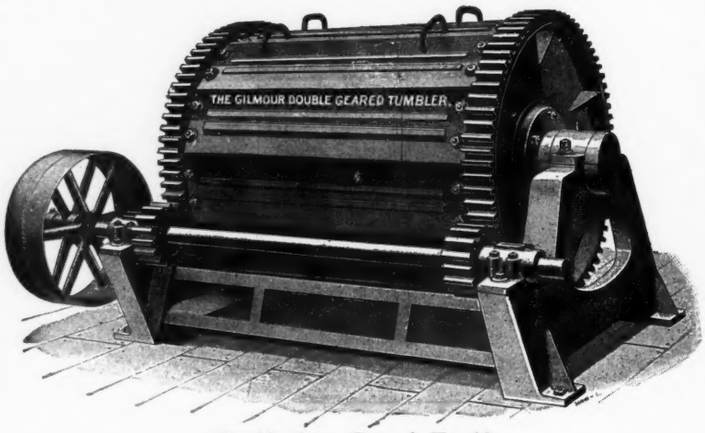
Ladles—

the substantial kind. Right here is where you get them; all sizes, all good, the kind the molders like, and they are excellent judges in this line.

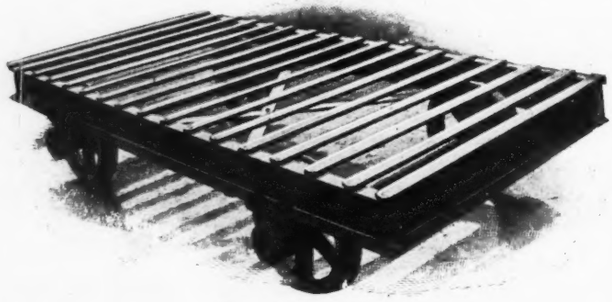
We have Air Hoists, Elevators and other up-to-date foundry equipments you ought to get prices on. Tell us what you need—we have it.

Gilmour's Double Spur-Geared Tumbler

is a rattling good mill—the best Rattler made. It is the longest lived and most practical mill ever put on the market. It is fitted with our improved hard cast angle staves, heads have renewal liners, bearings have dust-protecting castings and perfect oiling attachments. It is easy to empty and to refill, is built to last—in short, it is the tumbler foundrymen have long been looking for.



Double Spur-Geared Tumbler.



Core Oven Trucks.

Tramway Systems, too; of course you need one. What is the use of spending an hour getting things in and out of the shop when other people do the job in ten minutes? The way to meet competition is to have the right kind of equipment. You will find our trucks and turntables right.

Our new catalogue is now ready; write for one.

J. GILMOUR,

BENNETT BUILDING, NASSAU & FULTON STS., NEW YORK CITY.

THESE STEPS

in finishing a

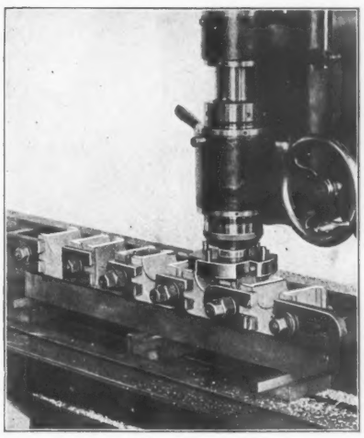
Connecting Rod Brass

on a

BECKER-BRAINARD VERTICAL MILLER

illustrate the great value of this machine for

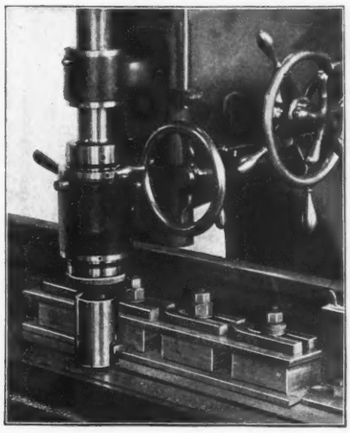
Repair Shop Work.

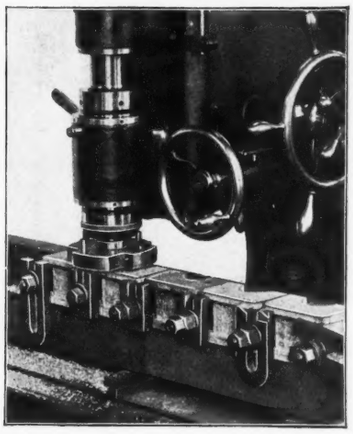


Facts and figures concerning the job are given in our

Bulletin M 26,

which you should write for.





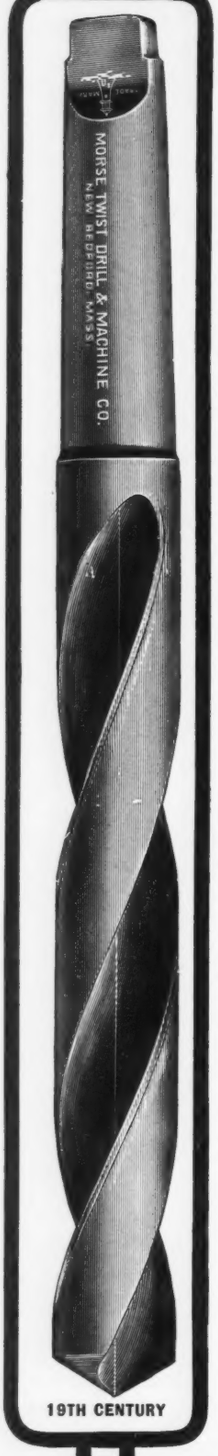
Our Vertical Miller can handle a great variety of work and will save time over other methods. Its design permits the work to be rigidly supported beneath the cutter, where it is readily visible. The patented auxiliary spindle support insures permanency of alignment of the spindle in relation to the platen.

We make all kinds of Milling Machines.

Becker-Brainard Milling Machine Co., of Hyde Park, Mass.

170

MORSE DRILLS.



19TH CENTURY

A boy walked into a London merchant's office in search of a situation. After being put through a series of questions by the merchant, he was asked, "well, my lad, what is your motto?" "Same as yours, sir," he replied. "Same as you have on your door,—'Push!'" He was engaged.

-Spare Moments.

No grass grows under our feet in our endeavor to keep abreast of the times. We are constantly pushing ahead and aiming to take the lead as manufacturers of fine tools. We must push in order to succeed. One instance of our push is the

20th Century Drill.

Compared with our 19th Century Drill do you not think we have used Sir Thomas Lipton's receipt for success: "Work hard, deal honestly, be enterprising, exercise careful judgment, advertise freely but judiciously, never despair, keep pushing on?"

We assuredly believe in that little word of four letters—

PUSH.

20TH CENTURY

Morse Twist Drill and Machine Co.
New Bedford, Massachusetts, U. S. A.

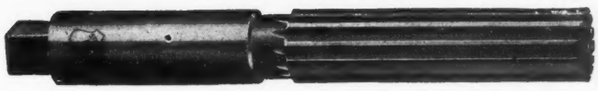
TWIST DRILLS HIGHEST QUALITY

THE STANDARD TOOL CO.

CLEVELAND NEW YORK

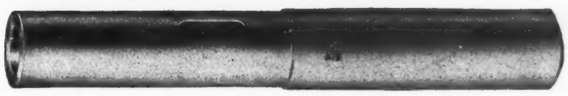
TWIST DRILLS HIGHEST QUALITY

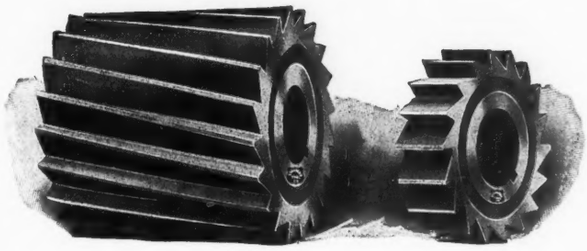
Every STANDARD Tool bears the Shield Trade Mark.



Twist Drills,
Drill Chucks,
Drill Gauges,
Sockets.

Taps,
Reamers,
Milling Cutters,
Special Tools.





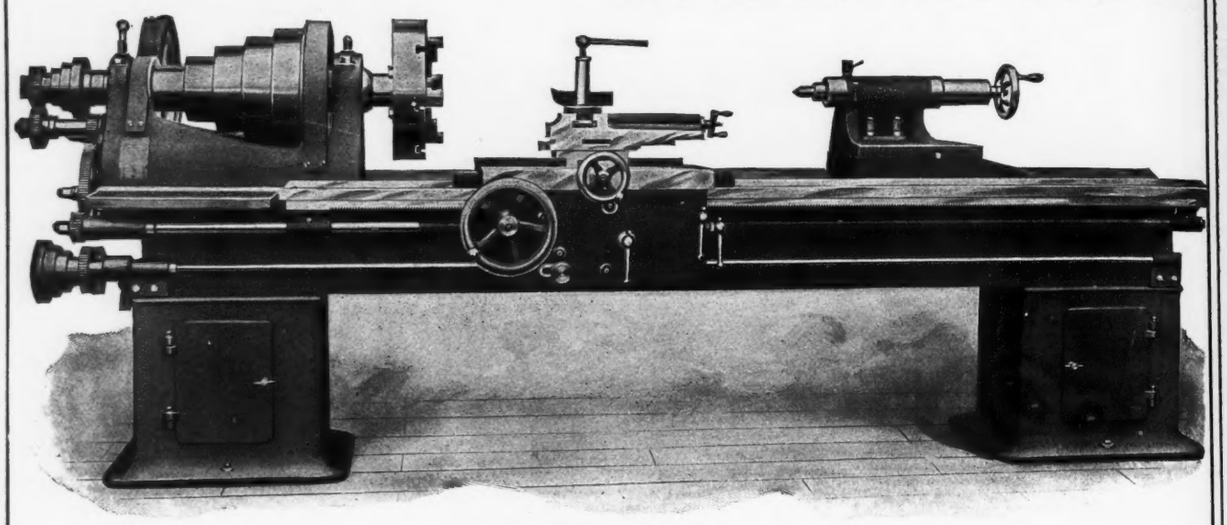
EUROPEAN AGENTS.

C. W. Burton, Griffiths & Co., London.
Burton Fils, Paris.
Jno. M. Sumner & Co., Milan.
Carl Blombach, Ronsdorf.
J. Lambercier & Cie., Geneva.
Carlos dal Re, Madrid.
Honore Demoor & Cie., Brussels.
F. W. Horne, Yokohama.

Are you looking for a Lathe or Shaper–

A good machine, embodying all improvements, guaranteed as to workmanship and material, a tool that will be worth what you pay for it, and that will pay for itself?

Let us make you a Price.

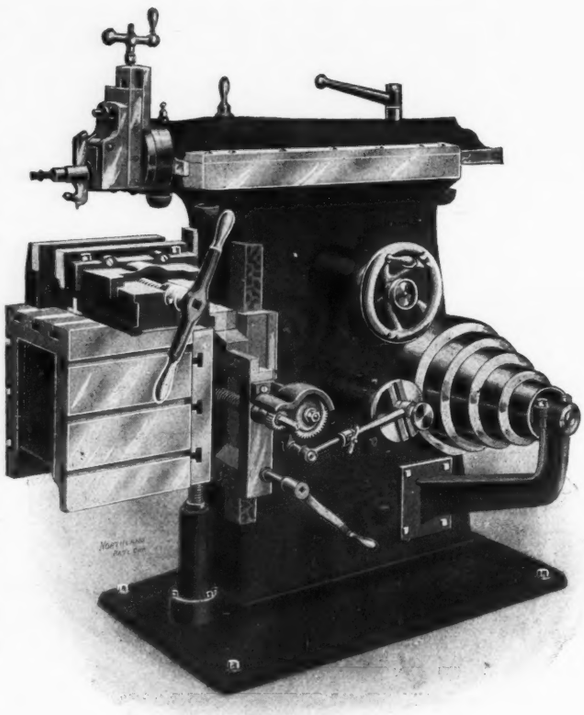


22-inch Engine Lathe.

22-in. Engine Lathe

Carriage and cross feed are operated by rod independent of screw, four changes of feed. The two feeds cannot be engaged at the same time and both are positive by means of gears, no friction or worms being used. Bed casting is deep and well braced, carriage long and well fitted. The lead screw is made from the best steel, as are all small pinions, shafts, studs and screws. The spindle is hollow or solid as desired. Large and small face plates, steady rest, countershaft and all necessary wrenches go with each machine.

Other sizes: 15 in., 18 in. and 32 in. swing.



16-inch Elliptical Gear Crank Shaper.

16-in. Elliptical Gear Crank Shaper with Back Gear

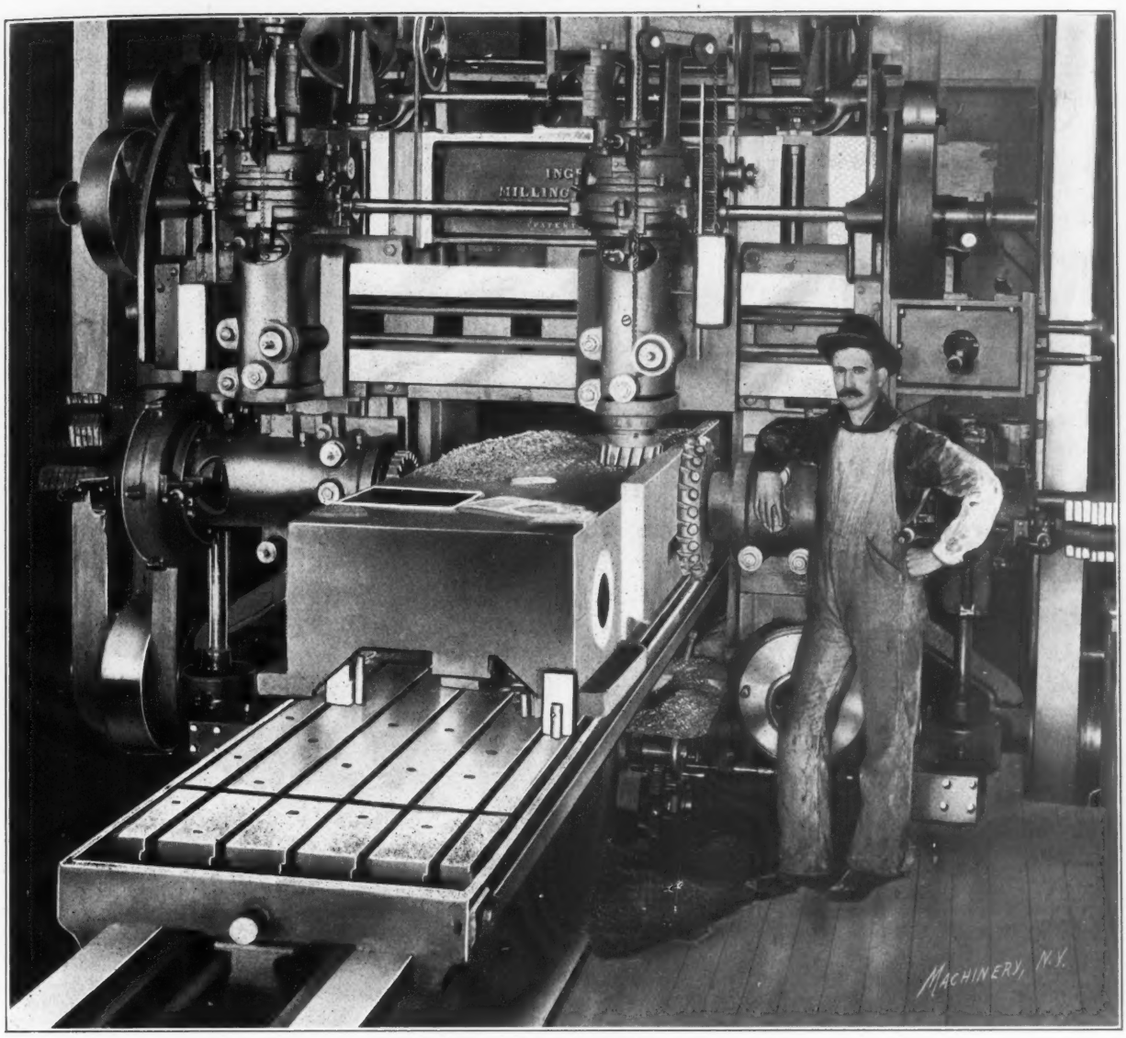
The stroke can be changed instantly while the machine is in motion, and the elliptical gears give a uniform cutting speed throughout the cut as well as uniform quick return on both long and short strokes. The ram is unusually stiff, and the projection of support for ram out over the table is an *original feature* which adds materially to the stiffness of the tool. The machine is back geared, giving ten changes of speed, and allowing heavy cut on all strokes.

Other sizes: Elliptical Gear Crank Shapers, 18 in. Geared Shapers, 15, 22, 26, 30, 34 and 48 in. stroke.

Geo. D. Walcott & Son, Jackson, Mich., U. S. A.

Our Tools can be seen at the Establishments of

Buck & Hickman, Ltd., London, Eng. Fenwick Freres & Co., Paris, France. McDowell, Stocker & Co., Chicago, Ill. Montgomery & Co., 105 Fulton Street, New York. Strong, Carlisle & Hammond Co., Cleveland, Ohio. J. W. Cregar Agency, The Bourse, Philadelphia, Pa.



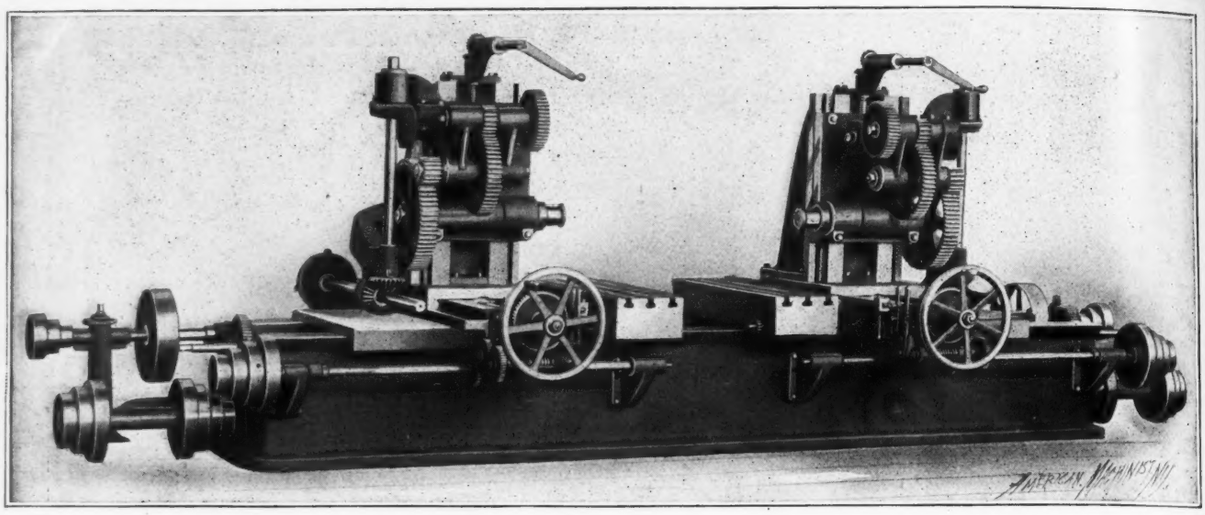
36 Cubic Inches of Cast Iron per Minute.

Not a record but an everyday performance of the Ingersoll Milling Machine. The engraving shows one of our four head machines at work on a large housing casting; the large face mill is 20 inches in diameter and takes a roughing cut 18 inches wide, 1-4 inch deep, 8 inches per minute, removing 36 cubic inches of cast iron per minute, while the other two cutters are milling pads and different surfaces on the same casting. If you have been doing work of this character with a planer, isn't this an object lesson in time saving?

We build heavy milling machines exclusively, one, two, three or four heads, horizontal spindle, combined vertical and horizontal spindle. It won't cost you anything to let us estimate what we can save on your work and it may be to your advantage.

The Ingersoll Milling Machine Co., Rockford, Ill.

Eastern Branch, 126 Liberty St., New York.

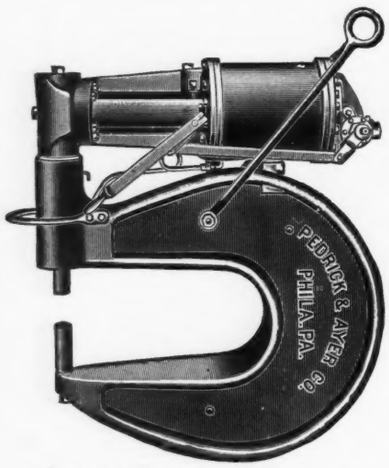


Our No. 4. Duplex Milling Machine

is of unusual construction and consists of a solid bed on which are mounted two tables and two saddles, each with horizontal adjustment. The upright on each saddle has horizontal movement at right angles to that of the saddle, and on each is a head with vertical movement and carrying a spindle. We build a large line of heavy milling machines making it and boring machines a specialty. Write us for detailed description of the No. 4 Duplex or any tool in the line of milling and boring desired.

The Beaman & Smith Co., Providence, R. I.

PEDRICK & AYER CO.,



Portable Pneumatic Riveter.

Air Compressors, Compressed Air Riveters, Hoists, Cranes and Other Tools For Shop, Yard and Foundry Uses.

Our New Line of Portable Pneumatic Riveters

comprises several styles and sizes and is adapted for any kind of work. These Riveters secure the maximum pressure on a rivet with as little weight in the machine as is possible. They work rapidly, without a jar or shock and give a uniform pressure upon the rivet.

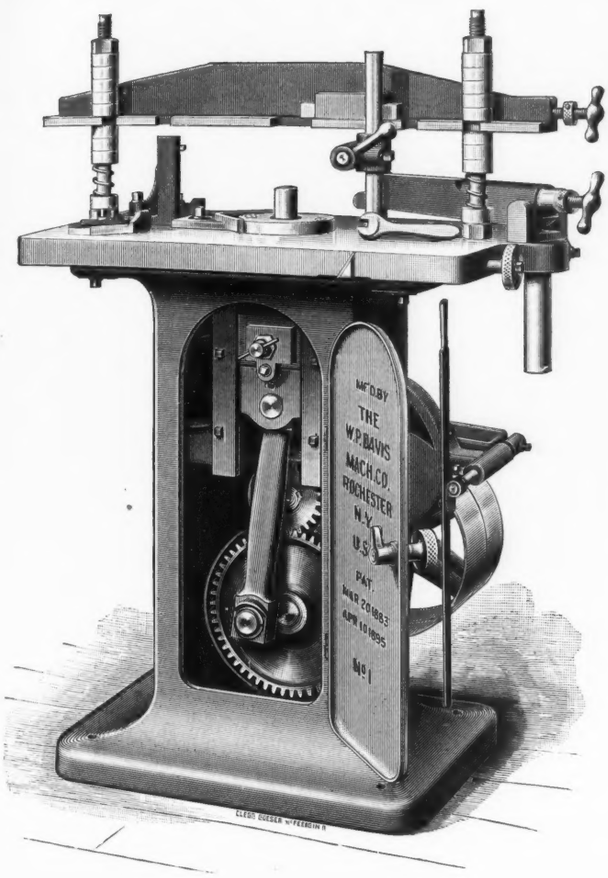
SPECIAL SIZES BUILT TO ORDER.

WRITE FOR CATALOGUE...

SOLE SALES AGENTS:

MANNING, MAXWELL & MOORE, 85-87-89 Liberty St., New York.

CHICAGO	BOSTON	PITTSBURGH	CLEVELAND	PHILADELPHIA
22-24-26 So. Canal St.	128 and 130 Oliver St.	Park Building.	Williamson Building.	Betz Building.

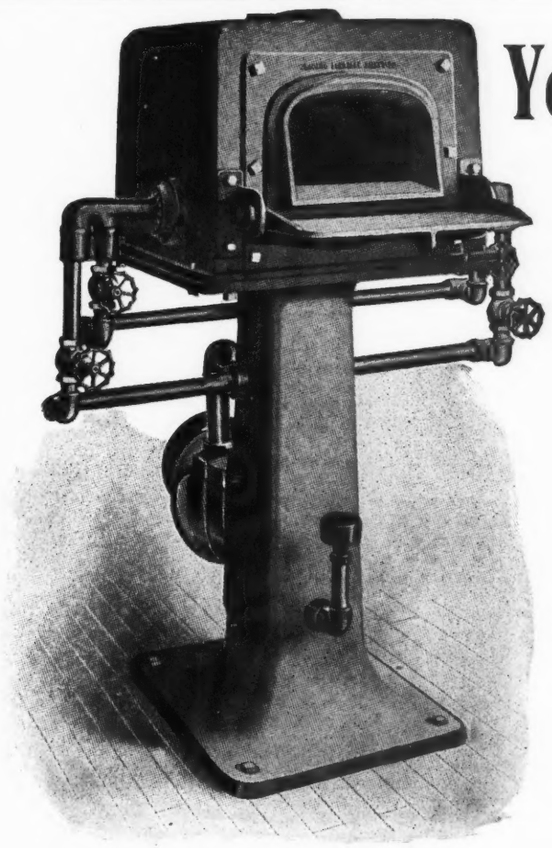


Key Seating

Do you cut key seats?
If so, how?
Do you get best results?
Why not?

Our No. 1 machine cuts key seats up to one inch wide by eight inches long; does it well and quickly. Will be sent on thirty days' trial to responsible parties. Can be ordered through any machinery dealer. Over 2,000 of these machines now in use, Price $125. net, as shown. Write and learn more about the machine, to

The W. P. Davis Machine Company
126-130 Mill Street, Rochester, N. Y.



Muffle or Oven Furnace No. 1. Price $85.

You Can't Coax a Man

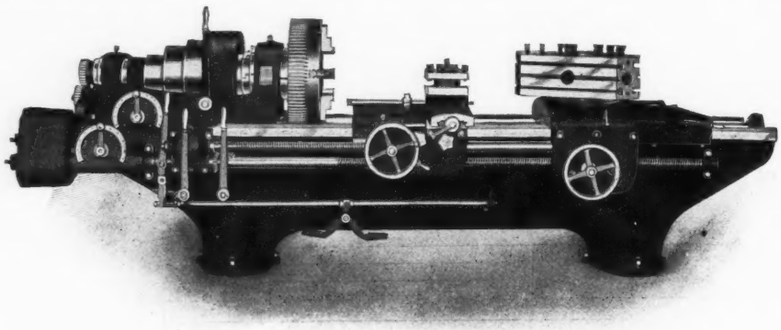
To give up the **Stewart Gas Blast Furnace** after he has once tried it any more than you can persuade him to give you two good dimes for a bad quarter. He has found out the difference between chancing results with an old style coal or coke furnace and the certainty of success that follows our method, and he is going to stick to the sure thing. Heating and hardening steel is a delicate process, a shade too much heat, variation in temperature, even ever so little, and the mischief's done — the tools ruined. The **Stewart** insures absolutely even temperature, does the work accurately, does it in less time, at less cost, and, better than all, does it right. A clean, convenient, economical device endorsed by hundreds of the leading machine and tool builders all over the country. May we send our catalogue?

Chicago Flexible Shaft Co.,
La Salle Ave. and Ontario St., Chicago, Ill.

FOREIGN AGENCIES: Niles Tool Works, 23-25 Victoria St., S. W., London. Fenwick Freres, 21 Rue Martel, Paris, France, Agents for France, Italy, Belgium, Spain, Portugal and Switzerland.

Rises to the Occasion

In these piping times of progress not only is unlimited power required of the modern machine tool but a multiplicity of feeds and speeds, facilities for quick handling, and strength to withstand the enormous cutting ability of the new high-speed steels. In heavy lathes for cast iron work these points are even more important than in other tools, and here is where the Milwaukee Turret Lathe rises to the occasion. This machine is designed to meet the new conditions, it has a greater number of feeds and speeds, a wider range of work, and more improvements of real value than any similar lathe. The "Milwaukee" is a product of the times—a work-producer and a money maker.



Get our booklet, "Reasons," for further "Milwaukee" facts.

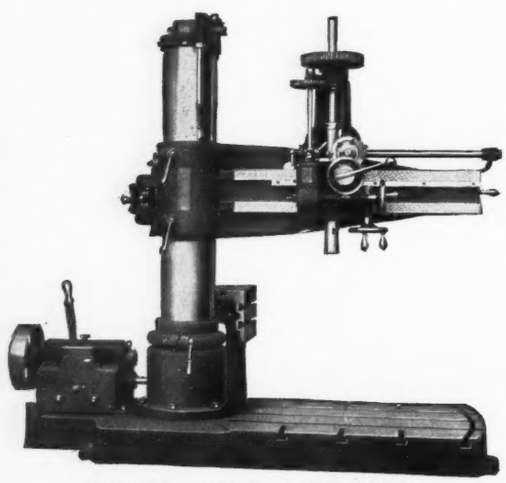
Milwaukee Machine Tool Co., Milwaukee, Wisconsin.

A Remarkable Example——

of rapid drilling is that shown in the accompanying cut, "A Twist Drill Chip," which is a half-tone made natural size from a chip taken from machinery steel by 1 9-16 inch drill. The exact feed at which this chip was taken is not known, as the machine is not provided with a feed of such coarseness, but it can be judged from the thickness of the chip—the chip being so located before the camera as to show its thickness—which measures 9-32 of an inch. In the performance of this operation there was no special preparation of the drill used, nor was the grinding changed, except that the drill had its center pointed up by hand on a thin emery wheel.

A TWIST DRILL CHIP.

This is one of the many examples of remarkable drilling done on this Machine; the others are fully described in "Drilling Extraordinary," a pamphlet which may be had for the asking. Send also for "*56 Points of Vantage.*"



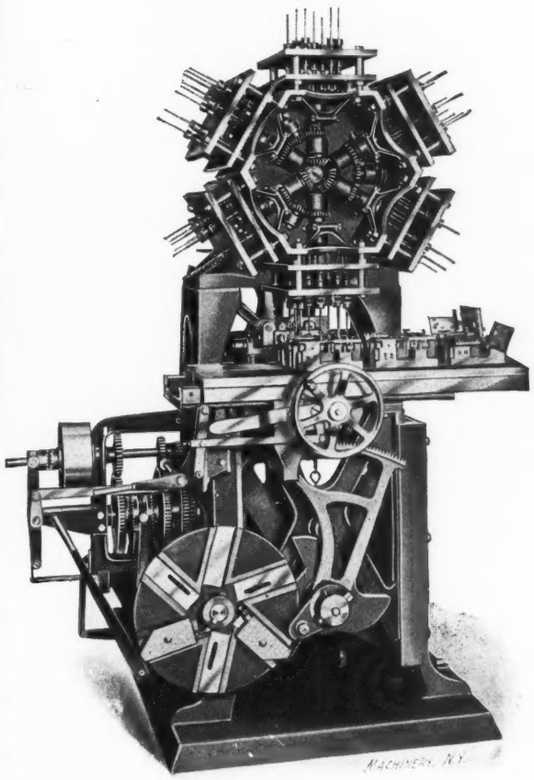
The New Bickford Radial.

The Bickford Drill & Tool Company,

Cincinnati, Ohio, U. S. A.

FOREIGN AGENTS—Schuchardt & Schutte, Berlin, Cologne, Vienna, St. Petersburg, Brussels, Stockholm and New York. Adolphe Janssens, Paris. Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. F. W. Horne, Yokohama, Japan

74-A—H.P.



Drilling Extraordinary.

Not only is the construction of NUTTING'S UNIVERSAL FULL AUTOMATIC DRILLING MACHINE a decided departure from the usual type of multiple drills, but the amount of work accomplished is distinctly remarkable. One operator running two machines can drill 21,600 holes in ten hours time—saving labor, time, floor space and at least 75 per cent of the ordinary drill breakage.

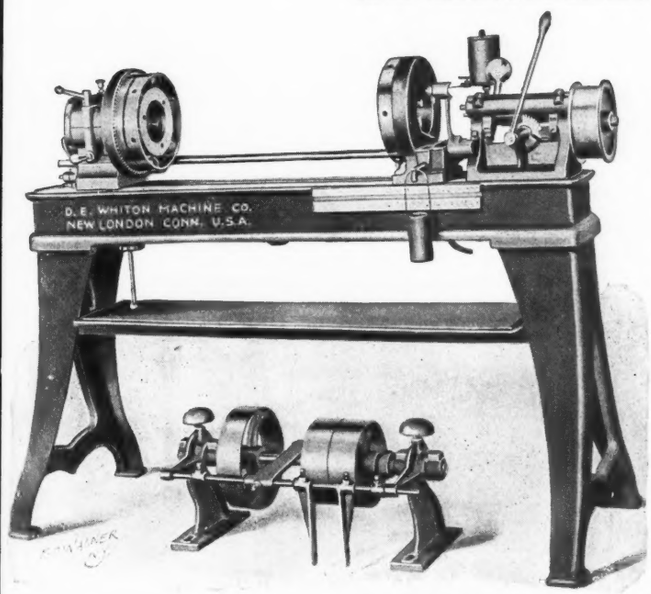
Adapted for wood or metal work; drills holes up to 1 inch, any distance apart, and every drill, regardless of size, runs at its proper cutting speed and maximum feed.

Can you afford to be without this money saver on duplicate drilling?

National Automatic Tool Co.,
Manufacturers
DAYTON, OHIO, U. S. A.

The Whiton Revolving Centering Machine

Designed to accurately center previously finished shafts four inches in diameter and smaller



THE work is held in two centering chucks, one of which revolves and acts as a drive. The shaft is firmly gripped in the revolving chuck, while the end near the tool is supported and revolved in the jaws of the stationary chuck as in a lathe center rest. The center may then be drilled and reamed to the required depth by the drilling and reaming tools which revolve in a direction opposite to the work and at different speeds. It is only in this manner that finished shafting can be centered to run perfectly true.

This new machine has all the advantages of our regular machines and the revolving attachment in addition. It has the same spindle mechanism, headstock and three-jaw centering chuck used in our Two-Spindle Centering Machine. Traverse of the spindles is limited by suitable stops; positive locking device for head prevents either spindle being advanced except when on center, and when advanced no lateral movement of the head can occur.

SEND FOR CIRCULAR AND PRICE LIST.

D. E. WHITON MACHINE COMPANY, New London, Conn., U.S.A.

Are You Seeking the Way

To Improve Your Product | **To Reduce Cost of Production** | **To Avoid Trouble?**

Our Finished Machine Keys

will do all this. They are saving many times their cost in the most progressive shops in the country,

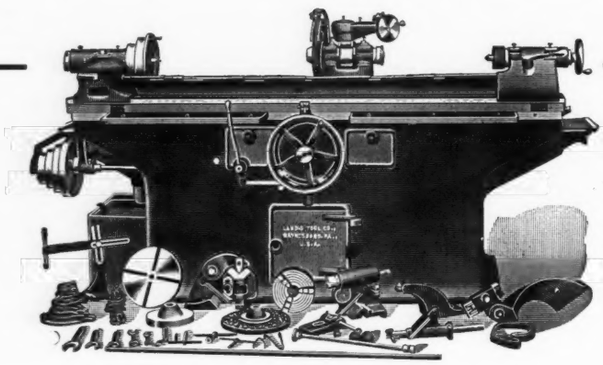
WE WANT THEM TO HAVE A TRIAL IN YOURS.

They are made of the best possible material by well-paid, skilled experts. No filing or fitting required. Made to order per your specifications.

Write for catalogue and price list. Do it today.

Standard Gauge Steel Co., Beaver Falls, Pa.

To the Betterment of Your Product



To the Increase of Your Profits

EVEN though your product does not require a great degree of accuracy, if you can secure the highest accuracy, increase your output, and lower cost of production by installing a machine for certain work, would it not be wise to secure such a machine without delay?

A Landis Grinder

will finish work that cannot be done on a lathe, and will do the work done on a lathe much quicker and better.

Let us send you our book about grinders and grinding.

Landis Tool Co., Waynesboro, Pa.

Agents...

Walter H. Foster, Manager, New York and Boston.

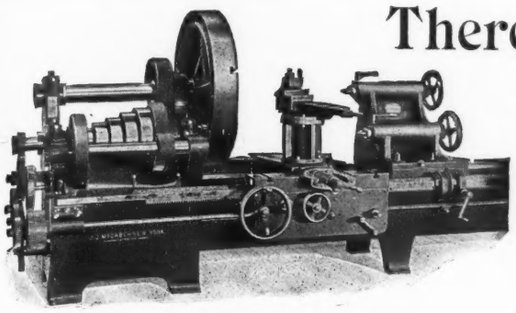
The A. R. Williams Co., Toronto.

Williams and Wilson, Montreal, Canada.

C. W. Burton, Griffiths & Co., London.

Schuchardt & Schutte, Berlin, Cologne, Vienna, Brussels, Stockholm and St. Petersburg.

There's No Lack of Power



New Heavy Pattern Double Spindle Lathe.

with McCabe's New Heavy Pattern Double Spindle Lathe; this was always a very powerful machine, but since the back gears have been put in front, thus permitting the use of a larger intermediate gear in driving the upper spindle, the power has been increased full 25 per cent. Any work that comes along, up to 48 inch swing, the lathe is ready for—and when there isn't a big job, keep busy with the small ones. 26 inch swing for the every day work and double the screw cutting capacity of any ordinary lathe. Remember, you get two lathes for the price of one when you get McCabe's.

Catalogue is interesting.

J. J. McCabe, 14 Dey St., New York.

TO PARTICULARIZE—

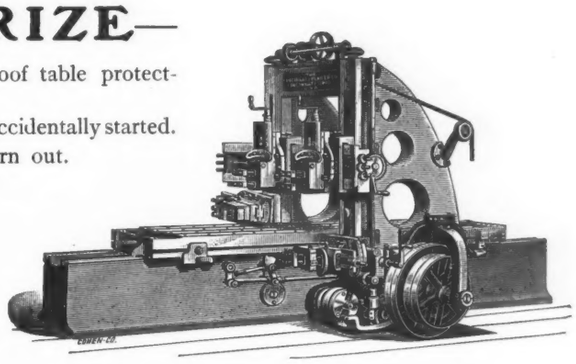
The CINCINNATI PLANER has a patent dirt-proof table protect- the Vs from dirt and chips.

A safety locking device so that the table cannot be accidentally started.

Patent combination friction that will not stick nor burn out.

Micrometer adjustment to down feed—and a score of other planer improvements. Get our Planer Book.

Smooth running, rapid, convenient, *the* planer of the day.



***The* Cincinnati Planer Company**
Cincinnati, Ohio, U. S. A.

No. 3 Miller

Hand Rack, Hand Screw and Screw Power Feed.

For Light, Rapid Work

there are no bettter machines built than

Fox Milling Machines and Fox Drills

Fox Hand and Power Millers are made in three sizes and noted for their speed, accuracy and durability.

Fox High Speed Drills are built with one, three and six spindles, and provided with three independent changes of speed for each spindle.

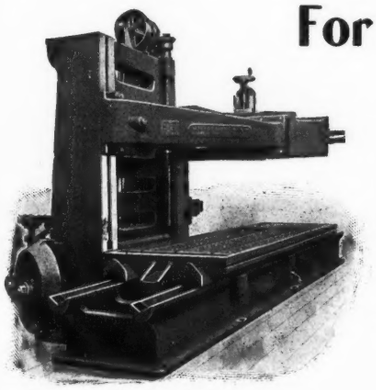
Write for special circulars of these and other high grade tools.

Fox Machine Company
815-825 North Front St., Grand Rapids, Mich.

No. 3

High Speed Drill

For All Machine Shop Work



the Open Side Planer is far more convenient than the regular two-post machine, because it is adapted for a great variety of work. It is exceedingly strong, is rapid in operation and runs smoothly. A comparatively small Open Side will do work which would require a much larger and more expensive tool of the old style.

We make Standard Open Side Planers from 30 inch to 72 inch; Open Side Extensive Planers, 84 inch, 96 inch, 120 inch.

Detrick & Harvey Machine Company
BALTIMORE, MD.

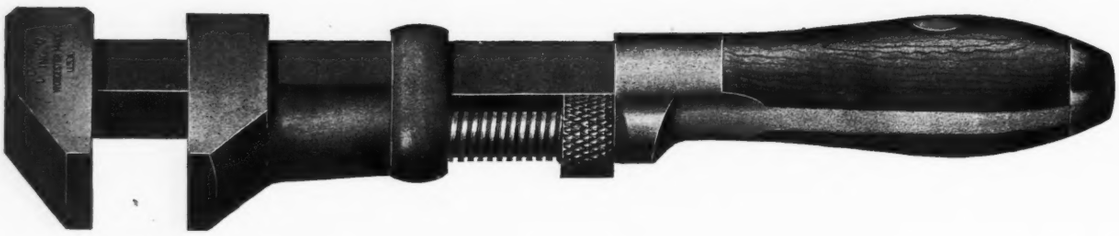
New Machinists' Set No. 21

Comprises the 1, 2 and 3 inch sizes of our Micrometer Calipers, enclosed in a fine morocco case of a shape convenient for the tool box. The frames of these calipers are drop forged of bar steel, with inserted hardened, tool steel anvil tips; all measuring screws are specially cut from unannealed tool steel to insure accuracy; work end of each screw carefully hardened, ground and lapped; adjustments for wear unequalled.

Let us mail you our Catalogue of Fine Machinists' Tools.

J. T. SLOCOMB CO.
Providence, R. I., U. S. A.

FOREIGN AGENTS—Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Glasgow and Newcastle-on-Tyne. White, Child & Beney, Vienna, Austria. De Fries & Co., Dusseldorf and Berlin.



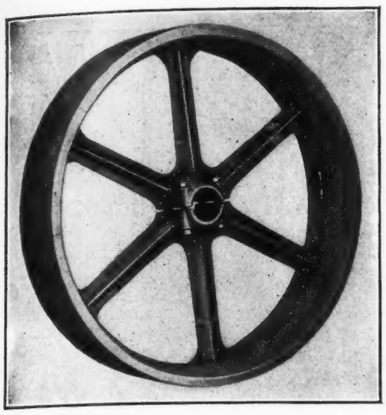
A "Knife-Handle" Wrench

A Wrench which has a handle mechanically SECURED AT BOTH ENDS, as well as by the rivet. Imitations depend on the RIVET ONLY to secure the wood. And there are other differences which are just as important. The COES excels in all minor points and is durable.

Trade Mark, "Knife-Handle" Registered April 9, 1895.

Coes Wrench Company, Worcester, Mass., U. S. A.

AGENTS—J. C. McCarty & Co., 10 Warren Street, New York.
John H. Graham & Co., 113 Chambers Street, New York. Holborn, London, E. C., 28 Vestergade, Copenhagen, K.



50% More Power

can be conveyed with a wood rim pulley, with belt at the same tension, than with a steel or iron pulley, and the reduction in strain on the belt produces a corresponding saving in belts, bearings and power.

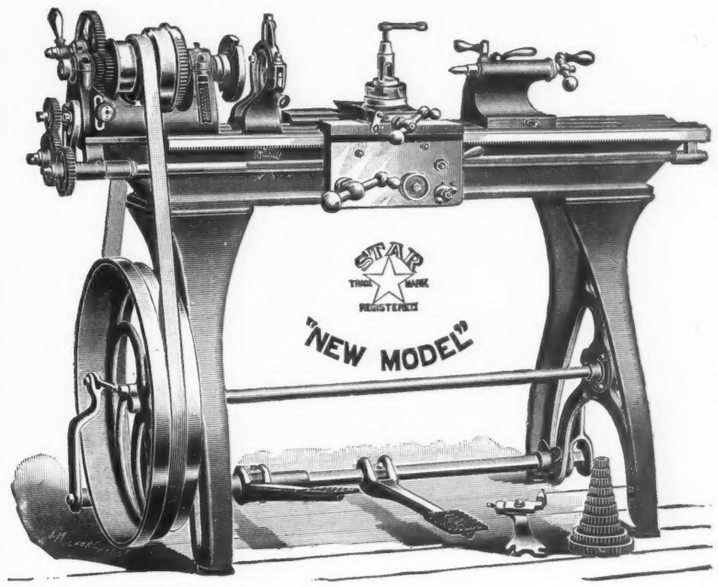
The New Wood Rim Steel Center Pulley

is a happy combination of the best features of the all wood and all steel pulleys with their well known faults left out. The wood rim carries a belt better than steel, the steel spokes do not fan the air and waste power, it has a steel hub with interchangeable iron bushings making a permanent fastening to the shaft, it is light, strong, well balanced and runs true. The best general purpose pulley on the market.

Sizes from 12 in to 60 in diameter.
Write us for particulars

Oneida Steel Pulley Co.
ONEIDA, N. Y.

Foot Power
"Star" Lathes



are high-grade, screw-cutting engine lathes, 9 and 11 inch swing, made to supply the demand for a foot power lathe containing the desirable features of the best power lathes and equal to any precision lathe for accuracy. A large number are also used with countershaft for light machine-shop and tool-room service. We guarantee complete satisfaction or your money back.

SOME FEATURES — Forged crucible steel hollow spindle, phosphor bearings, exclusive gear-driven reversible feeds, graduated cross feed screw, U. S. Standard, Whitworth or Metric lead screw, also can furnish Draw-In Chuck, Gear Cutting, Milling and Taper attachments.

ASK FOR CATALOG "B."

The Seneca Falls Mfg. Company

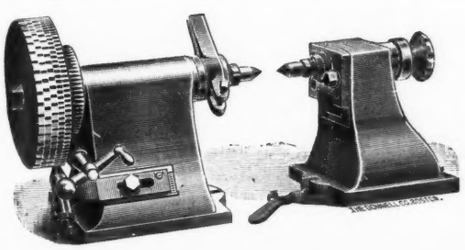
330 Water St., SENECA FALLS, N. Y., U.S.A.

71

THE BINSSE HORIZONTAL BORING MACHINE.

THE BINSSE MACHINE CO., Newark, N. J.

SOLE AGENTS: Prentiss Tool & Supply Co., New York, Boston, Buffalo. Brown & Zortman Machinery Co., Pittsburg, Pa. Marshall & Huschart Machinery Co., Chicago, Cleveland, Cincinnati. British Empire, Ludw. Loewe & Co., Ltd., London, Fenwick Freres & Co., Paris.

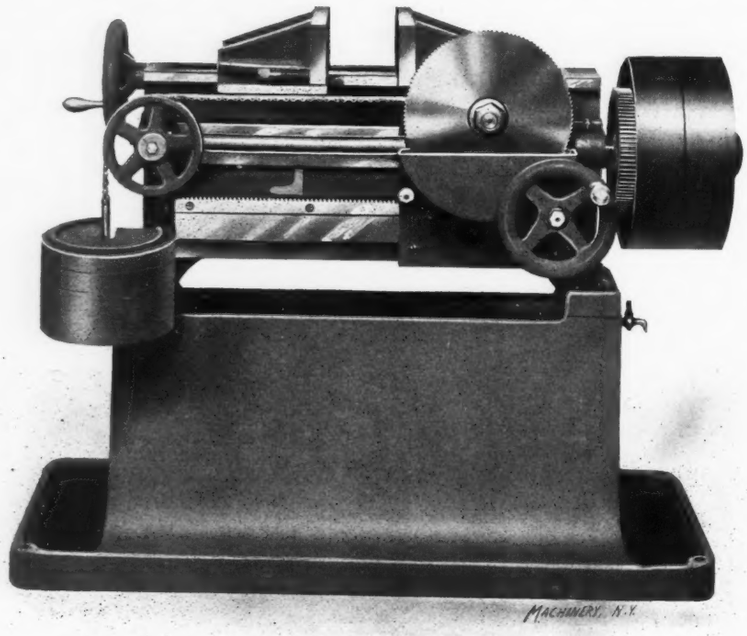


Improved Planer Centers

This center swings 13 inches and has improved index consisting of 5 circular plates, accurately notched and easily removable. The plates are cut through like a gear and give a much stronger pin than when drilled. Best material used throughout. Write us for details and other sizes.

FAY & SCOTT, Dexter, Me.

THE B. & C. METAL SAW



No. 1 Metal Saw, Capacity 3" x 6" in one cut, or 6", round or square, in two cuts.

Is above all things a *satisfactory* saw. It does a satisfactory day's work. The work is satisfactory when finished, and there is a satisfactory saving resulting from its speed and accuracy. Another satisfactory point is the price.

Write us about it and ask for our pamphlet "Saw Talk."

RESEK MACHINE TOOL CO., Cleveland, O.

THE

Standard=Auto=Addresser

A Perfect Addressing Machine

Combining

RAPIDITY 3000 envelopes, wrappers and postal cards printed per hour on hand feed machine. Our **Automatic Cutter** prints 8000 per hour. Cost of operation—a boy's time.

ECONOMY Lists compiled in your own office on a typewriter—at a total cost of $2.00 per 1000 different names. Other systems cost from $20. to $50. per 1000.

SIMPLICITY The construction of the machine is so simple your office boy or girl can take charge of your entire list.

It is a perfect office machine, about the size of a typewriter.

Our system is undeniably the cheapest and the best.

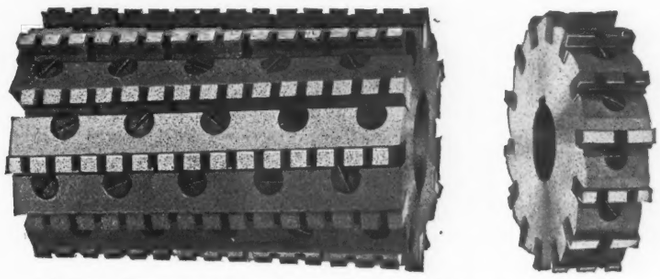
CATALOGUES AND PRICES SENT UPON APPLICATION.

Automatic Addressing Machine Company,

73 Warren Street, New York.

Adjustable Taps, Reamers, Milling Cutters.

Absolute reliability is the first essential with our tools; and if your tapping, reaming, and milling must be done to exact measurements you should use them. There is no question about the economy of using adjustable tools if they are reliable—and ours are. Let us show you how you can save money on this work and ensure absolute accuracy at the same time.

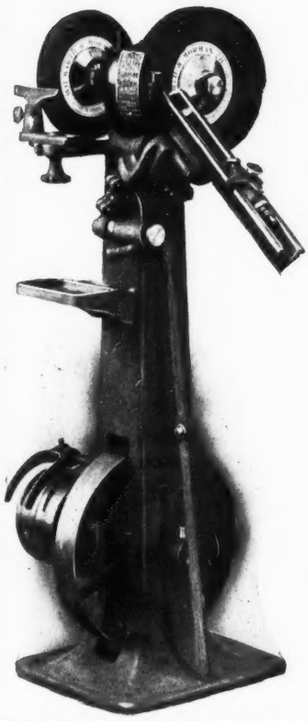


Milling Cutters with Inserted Teeth. All sizes made to order.

When ordered, we make these inserted teeth cutters with blades adjustable endwise by screws; alternate blades adjusted in opposite directions. This allows on a 2-inch face, an adjustment of ½-inch in width. Can't you use them?

Ott. Mergenthaler Company, Baltimore, Maryland, U. S. A.

An Apprentice's



first day's work in the shop may NOW include the CORRECT grinding of twist drills IF he has a NEW YANKEE DRILL GRINDER to do it on.

WE BRAG SO MUCH about simplicity of operation that we think you should be interested to know what right we have to do this.

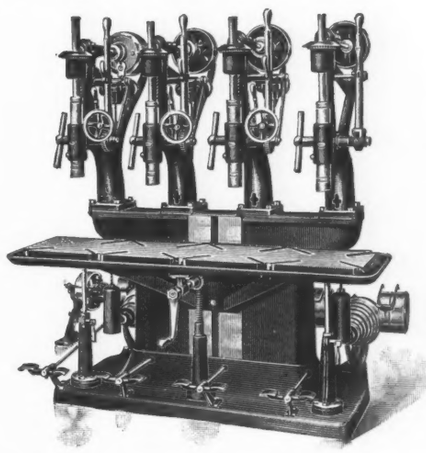
We are anxious to tell you and are awaiting your questions.

No good reason today for grinding drills by hand.

STYLE "A" with Point Thinning Wheel. One of Thirty Styles.

Wilmarth & Morman Co.
155 Canal St.
Grand Rapids, Mich.

Time Saved Means Dollars Earned



Our Gang Drills save time and labor, hence they are money makers.

The cut shows our Four Spindle 20" Drill, which is also furnished with Two and Three Spindles.

All spindles run independently and any desired arrangement of feeds can be supplied for same.

When built in our Manufacturers' style the spindles are self-operating having no feed levers to bother with.

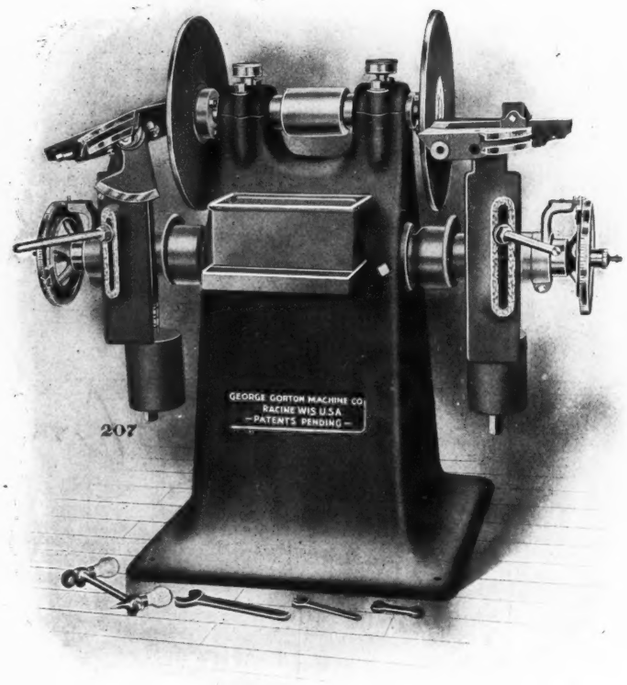
We also Gang our 23" and 26" Drills.

Write us about Gang Drills.

B. F. BARNES COMPANY,
Rockford, Illinois.

If you have Flat Surfaces to Grind you need a Gorton Disc Grinder

Not only because it is the best machine for all surface grinding, but because it will save from 50 to 75 per cent. on the cost of the work—and economy is wealth. The Gorton will reduce the time for finishing flat surfaces to one half or one third of that required by other methods, because as there is no danger of the wheels bursting they can be run at the highest speed. These wheels are steel discs, 18 inches in diameter, on the face of which emery cloth or paper is glued, making a perfect abrasive surface and one of almost absolute accuracy. The work is ground perfectly flat and true and by means of graduated protractors surfaces can be finished at any angle. We build twenty different styles of these machines, adapted for all flat grinding, and guarantee them to remove more stock in a given time than any other tool of this class. Send us a sample of the work you are doing, we will finish it on a Gorton, mark the time required and return the finished piece free of charge.



No. 6 A Disc Universal, Latest Improved.

George Gorton Machine Company,

Racine, Wisconsin, U. S. A.

Selig, Sonnenthal & Co., Victoria Street, London, carry all sizes in stock.

As Printers

We hustle for business as other men hustle,

But—when we get what we are after, your trouble is over;

The printing does the rest.

Because—Not one scrap of indifferent work can leave this place,

Because—Too many interested eyes scan every detail,

Because—We do not purpose giving the other printer a chance to jump on our fumble. You see, printing is a serious business; our welfare depends upon doing it right; your prospects are forwarded by the same token.

As a sample of what we mean, look at our work recently sent you.

Isn't that all right?

We can do as well for you at any time—

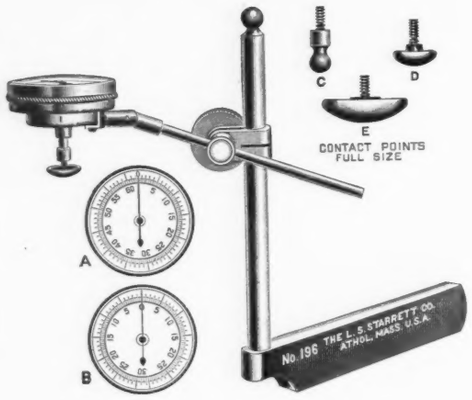
No one can do better.

Nothing too small—Nothing too large.

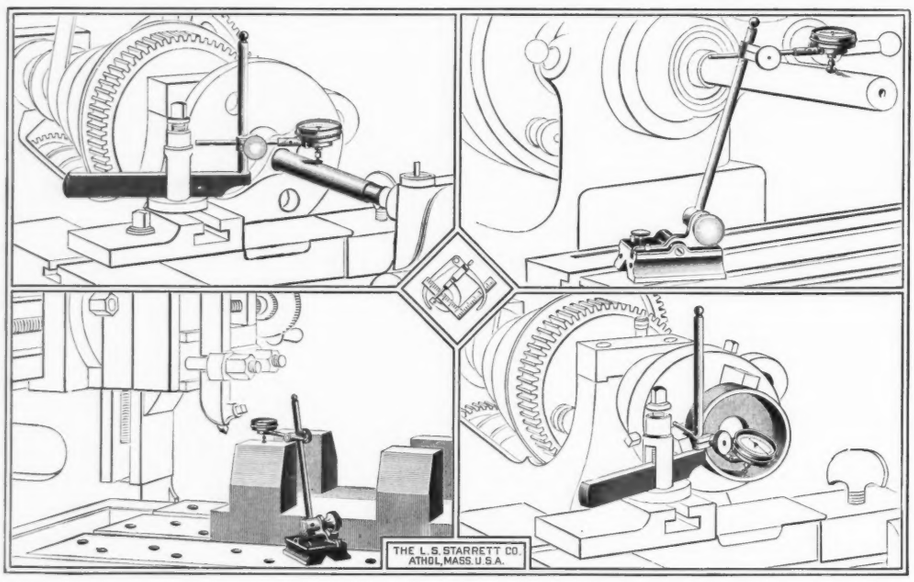
The Edgell Press

Starrett Dial Test Indicator.

No. 196



This Indicator is simple, reliable, easily read and very sensitive. The slightest pressure upon the contact point produces a movement of the hand on the dial. The circumference of the dial is divided into 125 equal spaces, each one representing a movement of the contact point of one-half thousandth of an inch. One revolution of the hand therefore indicates 1-16 inch, and two revolutions ⅛ inch, which is the capacity of the instrument. The dials are figured in two different ways: Style A is marked 0, 5, 10, 15, etc., to 62½, the figures donating thousandths, and is most useful in greater forward movement, measuring, indexing, spacing, etc.; Style B is marked from 0 to 31¼ to right and left, and is best for general use. By bringing contact point against the work with just enough pressure to give the hand one full turn, then setting it at 0, an opportunity is given for one full revolution of the hand to both right and left of 0, showing a rise or drop in the work and the amount of variation. A most valuable feature is the adjustable dial. By turning the knurled rim the dial may be instantly moved to bring the 0 mark to any point desired in relation to the hand. Each Indicator is fitted with friction joint and removable 3-inch rod, adapting it for use in any position, at the top, bottom or side of work; also with three hardened and ground contact points adapted for different classes of work.



PRICES.

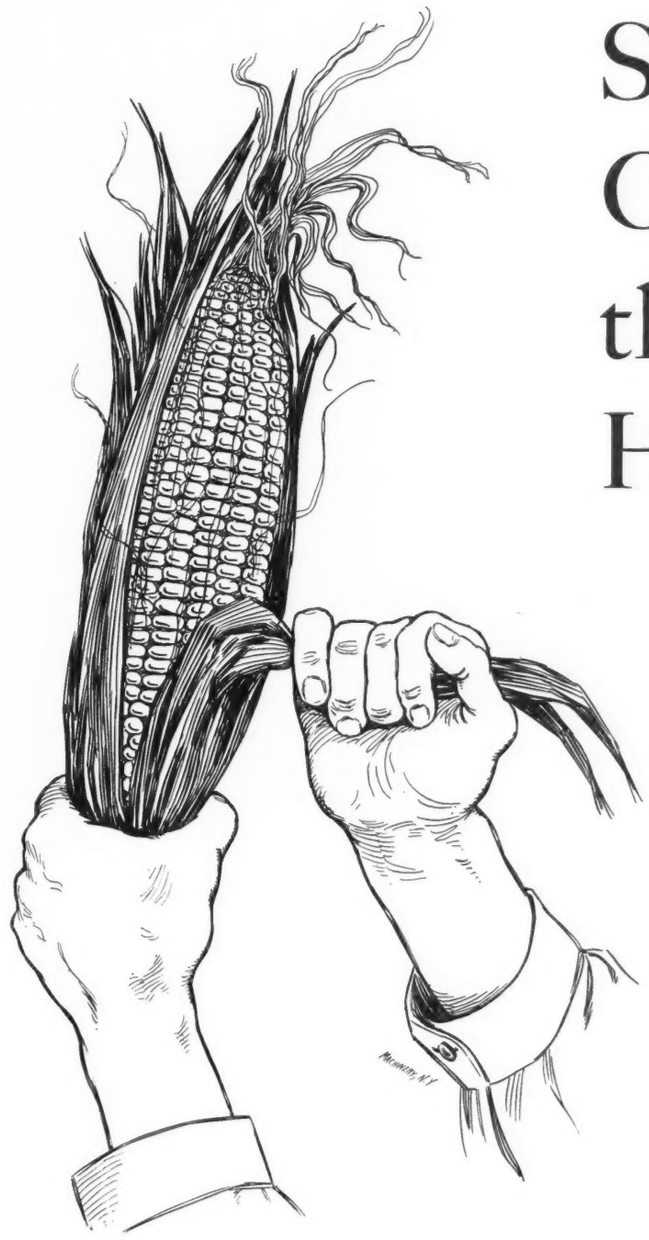
Indicator, A or B, with three contact points, and twelve safety screws each,	$7.00
Tool Post, extra,	.50
Surface Gauge sleeve, extra,	.75
Extra contact points, each,	.10
Extra safety screws, per dozen,	.15

Send for free Catalogue No. 17 D of Fine Mechanical Tools.

There is also a safety collar to prevent damage from an upward jam or crowding, and a small, hardened screw connecting the collar and contact point, with a V groove in the center. This little screw is strong enough to stand all the pressure necessary, but is intended to break under too much strain or side jam, and so prevent greater injury to the instrument. The broken ends are easily removed, and a new screw inserted.

The special tool post and sleeve as shown are useful in lathe work. For general work the Indicator is adapted for use with our 9-inch or 12-inch Surface Gauges. On lathe, planer, milling machine and in setting up machinery, this tool will be found indispensable when once used.

The L. S. Starrett Co., Athol, Mass., U. S. A.



Strips Off the Husks.

There is no padding in MACHINERY. Never have had room for anything of this kind. The articles in MACHINERY have always been condensed and right to the point.

But we have gone one step further.

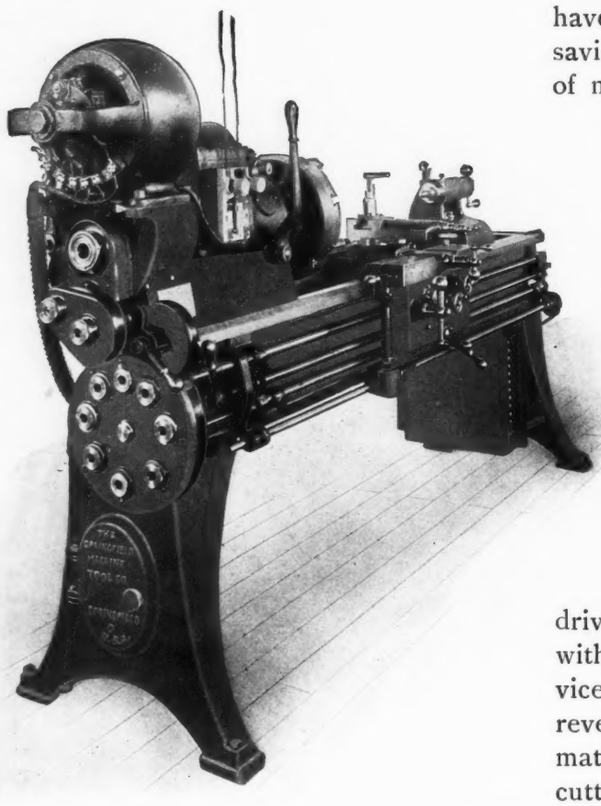
In the Engineering Review, published each month in the Engineering Edition of MACHINERY, is given the most information per square inch that was ever brought together in the pages of a technical paper. It contains the best summary of current technical events and current technical articles to be found anywhere. It literally strips off the husks and exposes the kernel.

This Getting at the Kernel is in large measure responsible for the splendid success of the Engineering Edition of MACHINERY among busy readers. Are you a subscriber?

Perhaps you have "time to burn" and can do your own husking.

Modern Tools and Modern Methods

have solved the time and labor saving problem in most every line of manufacture.

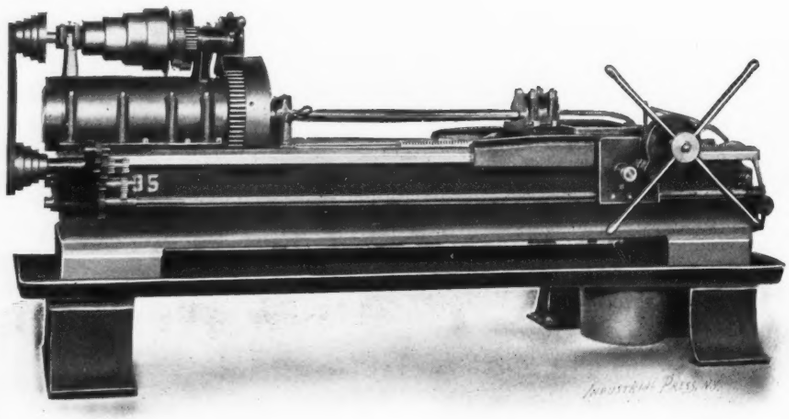


16-inch "Ideal" Engine Lathe.

Our 16-inch Ideal Engine Lathe

has been conceded an essentially modern tool, but connected with a Northern Electrical Mfg. Co.'s Variable Speed Motor —as shown in engraving—it's a step more up to date than when belt driven. The "Ideal" is equipped with patented gear changing device, friction-geared head spindle, reverse motion at carriage, automatic stop for turning and screw cutting and other valuable features. Circular for the asking.

Spindle and Axle Boring Machine.



Spindle and Axle Boring Machine.

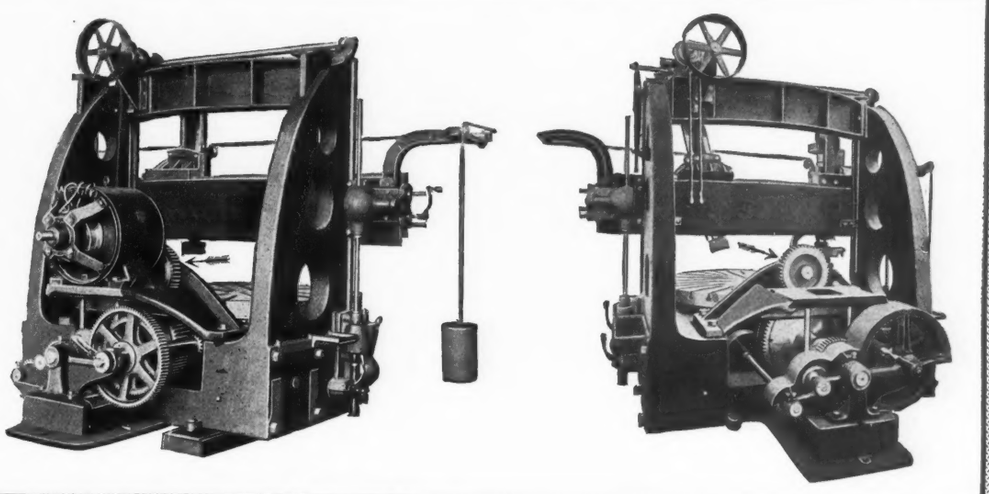
Another modern tool designed for boring holes ¾″ to 4″ in diameter through bars, spindles and axles from 1½″ to 7″ in diameter. This tool has ample power and a very wide range of feeds. By the arrangement for holding the bar to be bored, which, secured at one end in the chuck, passes through the hollow spindle and is supported at the other end by adjustable screw, furnished for the purpose, a comparatively short bed is required for boring long holes, adding greatly to the compactness and rigidity of the machine.

The Springfield Machine Tool Co., Springfield, Ohio.

Manufacturers of Brass and Iron Working Machinery.

AGENTS—The Garvin Machine Co , New York and Philadelphia. The C. H. Wood Co., Syracuse, N. Y. The Carey Machinery and Supply Co., Baltimore. McDowell, Stocker & Co., Chicago. The E. A. Kinsey Co., Cincinnati. The Fairbanks Co., Buffalo, N. Y. Chas G. Smith Co., Pittsburg. California Hydraulic Engine & Supply Co., San Francisco.

NOISELESS PINIONS FOR MOTOR DRIVEN TOOLS



MOTOR driven tools equipped with high speed motors and using a gear drive are being largely adopted in modern machine shops on account of their remarkable efficiency. The main objection to them is the fact that the gearing is very noisy. To avoid this the leading manufacturers and users are adopting New Process Noiseless Pinions, thus doing away with the unbearable racket without decreasing the efficiency or durability of the drive. Above are shown two views of a motor driven Bullard boring mill equipped with a New Process intermediate pinion. One view shows the motor in place. In the other it is removed, exposing the pinion. Our "Noiseless Pinion" booklet would interest you.

The NEW PROCESS RAW HIDE CO.

SYRACUSE, N. Y.

Hair-Breadth Exactness

A perfect tube must be exact in gauge—exact in diameter.

The hair-breadth exactness in gauge and diameter is a feature about

Standard Seamless Tubing

that makes it well-nigh perfect.

Buy Standard Tubing and you'll also get a finish not found in the ordinary tubing.

A nice tube finish makes work easier—easier work means more work—more work—more money.

It's therefore more money for you if you use Standard tubing. Our Price Proposition will prove this—why not write for it?

The STANDARD WELDING CO
CLEVELAND OHIO

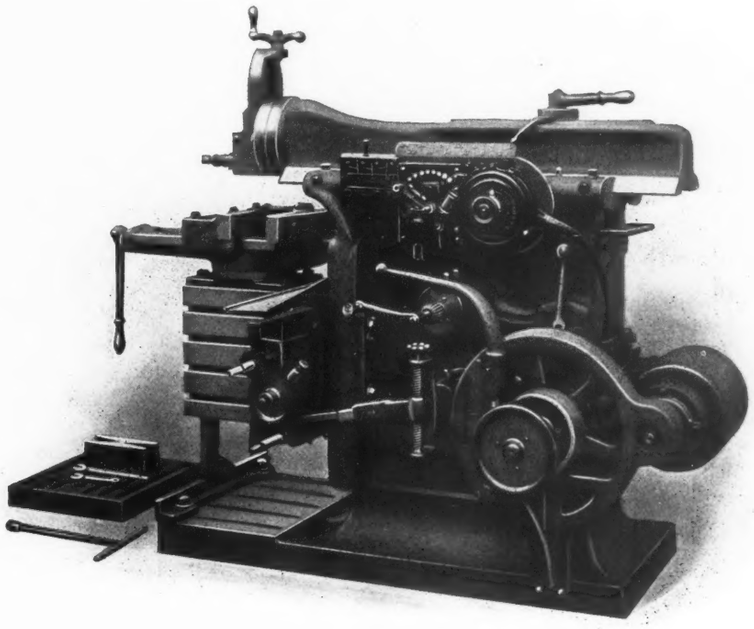
Just turn the Knob

That's all the operator has to do when he wants to change the cutting speed. Changed instantly to suit the metal being worked; no hunting around for a stick to shift tight belts. From 5 strokes per minute back geared, to 100 strokes single geared, can be obtained on our new variable speed motor driven shaper.

New (patent pending) clutch and brake arrangement, by means of which the machine can be stopped instantly at any part of stroke.

All controlling handles within convenient reach of operator without leaving working position at machine. Designed to obtain the fullest possible benefits from the new "high duty" cutting steels and to reduce part-finishing costs.

If interested, write for particulars.



OUR NEW "HIGH DUTY" COST REDUCER.

Eberhardts' Patent 24" Extension Base Shaper, with Variable Speed Electric Motor Drive

NOTE:—This motor is suitable for single voltage, direct current, but we can furnish our machines with any make of constant or variable speed motor for any voltage, to suit customer's requirements.

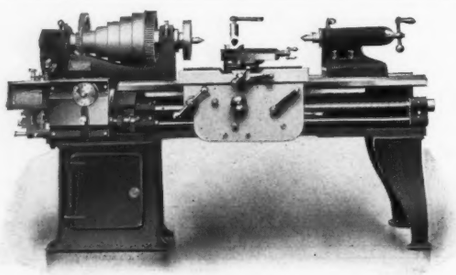
Of course we make belt driven shapers, too. Our ad. in June MACHINERY illustrated *one order* for fourteen of the 24-in. Extension Base style for a prominent railroad system.

Gear Cutting Machinery. Shapers. Drill Presses.

GOULD & EBERHARDT, NEWARK, N. J., U. S. A.

SELLING AGENTS—Manning, Maxwell & Moore, New York and Boston. Baird Machinery Co., Pittsburgh, Pa. Marshall & Huschart Machinery Co, Chicago and Cleveland. The Fairbanks Co., Philadelphia. Henshaw, Bulkley & Co., San Francisco and Seattle. W. R. Colcord Machinery Co., St. Louis. Prentiss Tool & Supply Co., Buffalo.

FOREIGN AGENTS—Schuchardt & Schutte, Berlin, Cologne, Vienna, Brussels, Stockholm, St. Petersburg. Selig, Sonnenthal & Co., London, England. John Lang & Sons, Johnstone, Scotland. Roux Freres & Co., Paris, France. White, Child & Beney, Shaper and Drill Press Agents, Vienna.



Schumacher & Boye 18-in. Engine Lathe

With Patented Change Gear Device. Forty Changes Without Duplication, as shown in the index:

TOP INDEX HANDLE IN HOLE	CUTS	FRONT INDEX HANDLE IN HOLE 1	2	3	4	5	6	7	8
1	Threads per inch	2	2¼	2½	2¾	2⅞	3	3¼	3½
2	" " "	4	4½	5	5½	5¾	6	6½	7
3	" " "	8	9	10	11	11½	12	13	14
4	" " "	16	18	20	22	23	24	26	28
5	" " "	32	36	40	44	46	48	52	56

FEEDS 4 TIMES THREADS PER INCH.

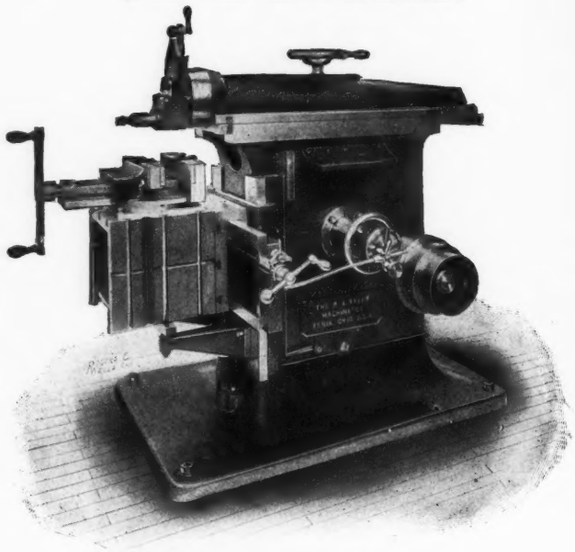
W. T. Eames Patent, Aug. 26, 1902, Oct. 28, 1902.

Schumacher & Boye, Cincinnati, Ohio, U.S.A.

ENGINE LATHES, 18 TO 54 INCH SWING.

Plain or Back Geared

Just as You Prefer.



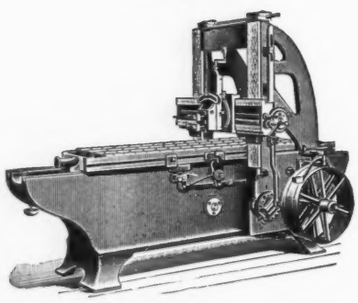
This 26 inch Crank Shaper

can be used as a plain or a back geared machine as the circumstance of the moment requires. The ram is very stiff with slides projecting back and front on column, thus giving strength to the machine. Finest workmanship, all improvements.

Descriptive circular of full line.

The R. A. Kelly Co., Xenia, O.

MACHINERY



24 in. x 24 in. Planer

This planer is the result of many years experience in designing and building Metal Plating Machinery. It contains many new and valuable improvements not found in other Planers.

Great care has been taken to avoid complication in working parts and to so arrange these parts as to be easy of access, quick and easy in operation.

Material and workmanship are of the highest class.

Each Planer is thoroughly tested before being shipped. Write today.

Baird Machinery Company,

123 Water Street, PITTSBURG, PA.

The Three Vital Points

in an

Automatic Turret Lathe

are

Accuracy, Adaptability, Amount of Output,

and in these none equal

The GRIDLEY.

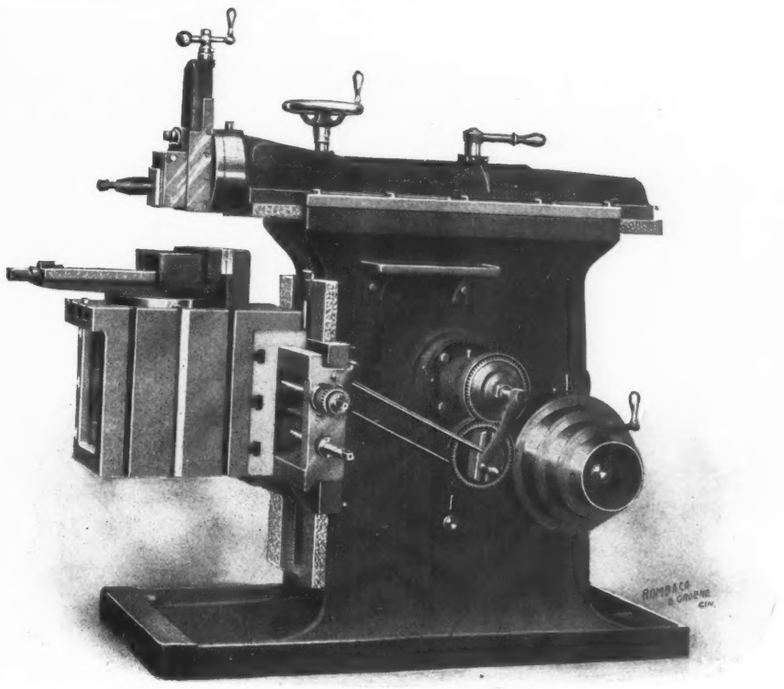
Better than the others in other ways too.
Ask us about it.

Windsor Machine Company,
Windsor. Vermont, U.S.A.

Shaper Facts.

Our 20-in. Shaper

can be used either as a single or back geared machine, thus giving it eight cutting speeds. IT HAS an extension base, extra length of ram bearing in the column, also large bearings all through, and all hand scraped to surface plates, lock nuts to gib adjusting screws in ram and down feed slides, tool steel jaws to vise, positive self adjusting feed rod, a large opening under the ram for key seating, means for adjusting and positioning stroke of ram while in motion, all gears and tee slots cut from the solid, and *weight, rigidity, accuracy* and *power*, and, as extras, outer support to table, power down feed to head, revolving table, tilting table, concave attachment, cone mandrels, etc.

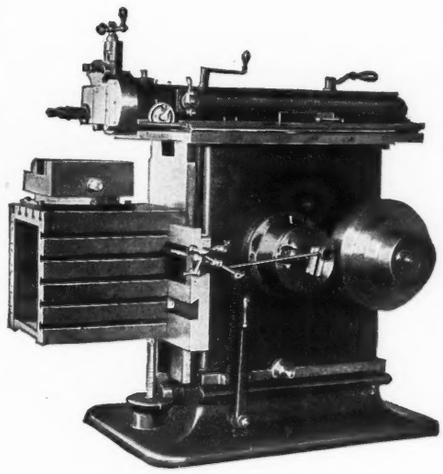


OUR CATALOGUE gives other facts, also SHAPER FIGURES of this and our other machines; we will send it to you on request.

The Cincinnati Shaper Co.

Elam St. and Garrard Ave. **CINCINNATI, OHIO.**

Standard of Efficiency.

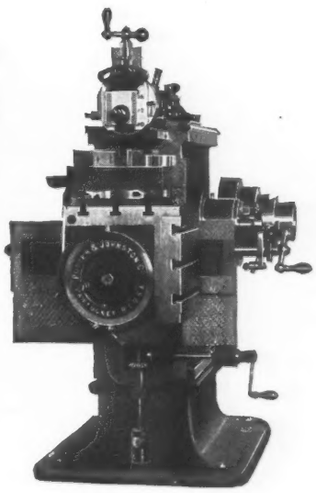


24-inch size.

Potter & Johnston Universal Shaping Machines. **15 and 24 in. stroke.**

Heavy, Powerful, Convenient, Accurate.

Write for circular telling all about their universal features.



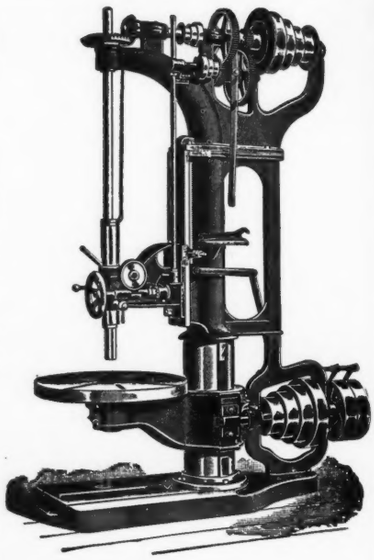
15-inch size.

Potter & Johnston Machine Co., Pawtucket, R. I., U. S. A.

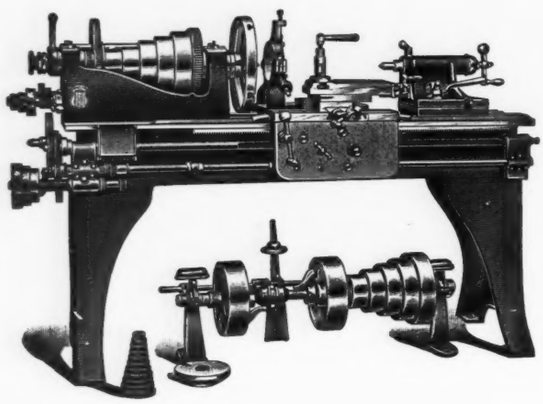
New York Office, 126 Liberty St., Walter H. Foster, Manager.

FOREIGN AGENTS—Chas. Churchill & Co., Ltd., London, Birmingham, Manchester and Newcastle-on-Tyne, England, and Glasgow, Scotland.

Our Line of Lathes and Drills



Covers the field pretty thoroughly, what ever your needs may be. Engine Lathes range in size from 13 inch to 31 inch swing; built with extra large spindle bearings, carriage gibbed front and back with long bearings on bed. Upright Drills in sizes from 20 inch to 50 inch, designed with special regard to convenience in operation; quick return motion, balanced spindle and automatic stop.



All essentials necessary to produce strength and durability are embodied in Blaisdell Tools.

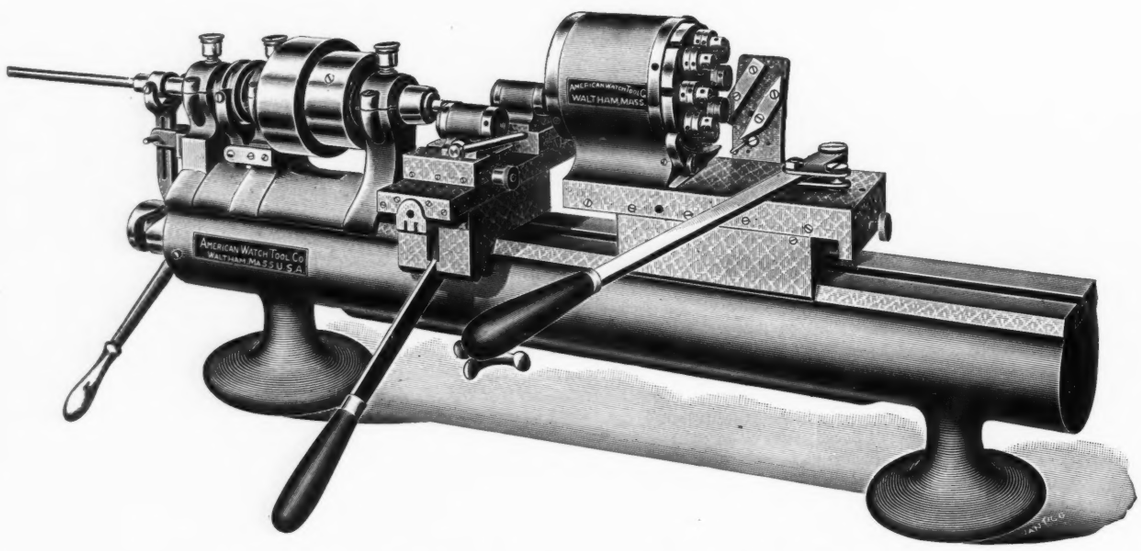
Catalog covering full line of manufacture yours for the asking.

P. BLAISDELL & CO.

26 JACKSON ST., WORCESTER, MASS., U. S. A.

FOREIGN AGENTS—C. W. Burton, Griffiths & Co., London, Eng Henry W. Peabody & Co., France and Australia. V. Lowener, Copenhagen, Denmark. Wilh. Sonesson & Co., Malmo, Sweden. Deutsche Garvin Maschinen Fabrik, Burg Strasse 17, Berlin, Germany. Splethoff, Beeuwkes & Co., Rotterdam, Holland.

No. 4 Turret Lathe.



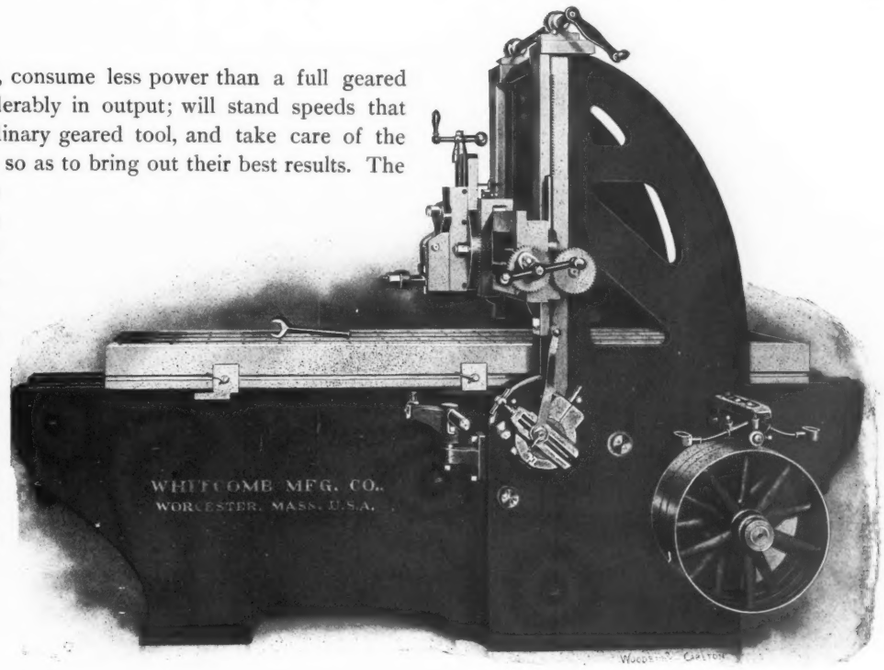
Headstock will take 9-16″; swing 8 1-2″; bed 36″ long.

LOOP-LOCK MACHINE COMPANY

Successors to **American Watch Tool Company** **WALTHAM, MASS.**

Whitcomb Second Belt Drive Planers are especially adapted to the severe requirements of modern shop practice.

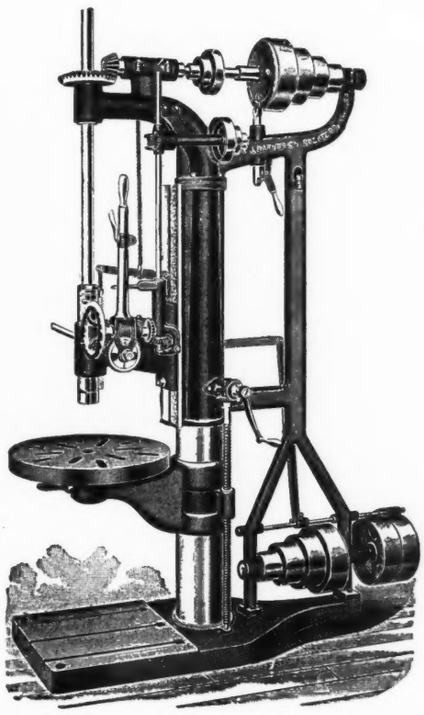
They are powerful, rapid, consume less power than a full geared planer, yet beat it considerably in output; will stand speeds that would soon ruin the ordinary geared tool, and take care of the latest improved tool steels so as to bring out their best results. The second-belt drive so softens the action of the planer that it runs without jar or shock and practically without noise, reverses gently yet promptly and offers very little opportunity for backlash to appear in the gearing. Simple in construction, not liable to get out of order and the most convenient planers on the market.



New Planer Catalogue mailed on request.

Whitcomb Manufacturing Co., Worcester, Mass.

26 Inch Swing Drill



Back Gear - Sliding Head
with Wheel Feed - Lever Feed
Power Feed

ALL ON THE ONE DRILL

Points to Consider

Convenience of operating is rapidity in work.
Workmanship is durability; (poor work don't last long.)
Enclosed back gear is the strongest, cleanest and doesn't throw oil.
Price and delivery an important feature.
Reputation guarantees a tool.

8 Inch to 50 Inch Drills

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(Established 1872)

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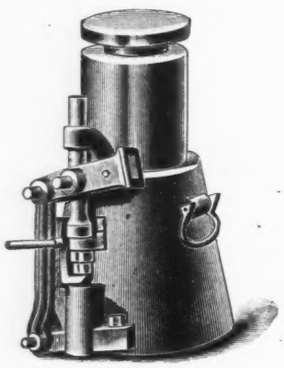
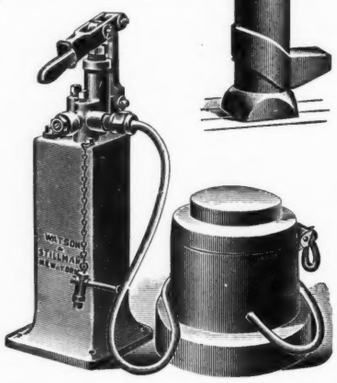
Rockford, Illinois, U. S. A.



There are Jacks and Jacks, but a Watson-Stillman Hydraulic Jack is what you need—

and there is one for *every* need, 257 styles and innumerable sizes. We can "jack" things up, "jack" them down, push them sideways, pull them lengthways; there are odd little Jacks for unget-at-able corners, and Jacks that can be worked where there's hardly a foothold—in fact we make most every kind of Jack you ever heard of and some special styles you'd hardly know the use of.

We have a separate catalogue for Jacks, we'll send it if you are interested.

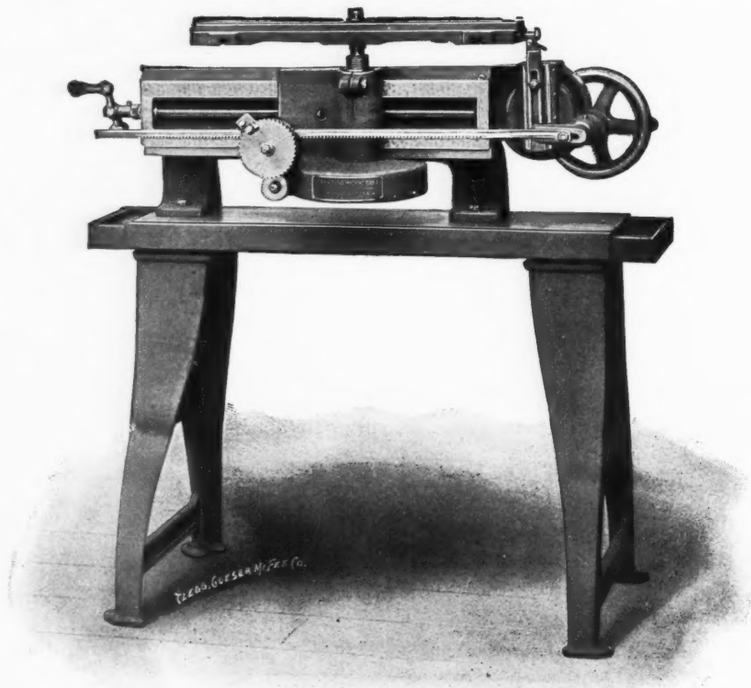


The Watson-Stillman Company,

CHICAGO OFFICE,
453 ROOKERY.

204-210 East 43d Street, New York City.

NEW GRADUATING MACHINE.



The machine shown herewith is designed for graduating all cylindrical parts. It will take work from the vertical to the horizontal, and the graduating head swings through an angle of 90 degrees. This machine will produce ten times as much work as an automatic gear cutter or milling machine, besides regulating the lengths of lines, insuring accuracy and no spoiled work.

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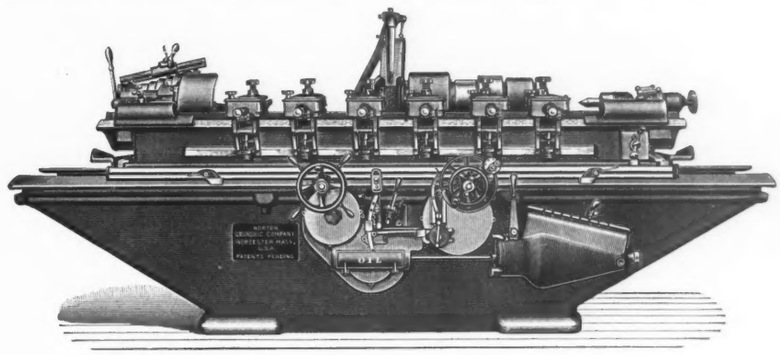
The R. K. LeBlond Machine Tool Co., 4605 to 4621 Eastern Ave., CINCINNATI, O., U.S.A.

J. Lambercier & Co., Geneva, Sole Agents for Switzerland.

It is one thing to keep up with progress—and quite another thing to anticipate conditions a little in advance.



THE "NORTON" PLAIN GRINDING MACHINES

have anticipated and provided for conditions in commercial grinding.

Cylindrical grinding and finishing by the use of "Norton" Grinding Machines and Wheels can now be done at a saving of cost and with an accuracy not thought possible even one year ago.

OUR PLANT IS WELL WORTH YOUR WHILE TO VISIT.

"NORTON" GRINDING MACHINES LEAD ALL OTHERS.

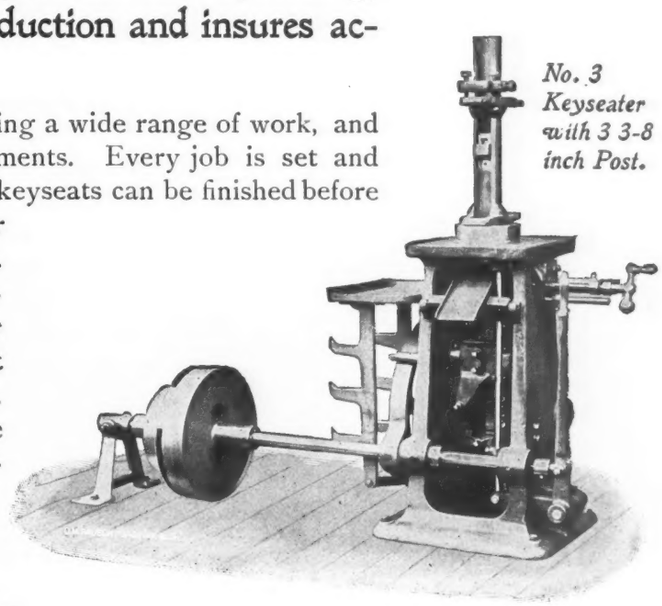
Grinds work 6 feet, 8 feet, 10 feet, 12 feet, and 14 feet long.
Better see us or write to us.

Manufactured by **NORTON GRINDING COMPANY,** Worcester, Mass., U. S. A.

Mitts & Merrill's Giant Keyseater

Solves the time saving problem in keyseating, permits economy in production and insures accurate work.

The machine is built in six sizes covering a wide range of work, and is quickly adjusted to different requirements. Every job is set and fastened by its bore and two ordinary keyseats can be finished before one piece can be fastened ready for keyseating on any other style machine. Will cut perfectly true keyways whether the hole is straight or taper or whether the hub is faced true or left rough as it comes from the foundry. The support being absolutely solid, the tool cannot spring. Send for Keyseater book—mailed free.



No. 3 Keyseater with 3 3-8 inch Post.

Over 300 of these machines in use by the leading shops of America and Europe.

MITTS & MERRILL, 843 WATER ST., SAGINAW, MICH., U. S. A.

FOREIGN AGENTS—C. W. Burton, Griffiths & Co., London, England.
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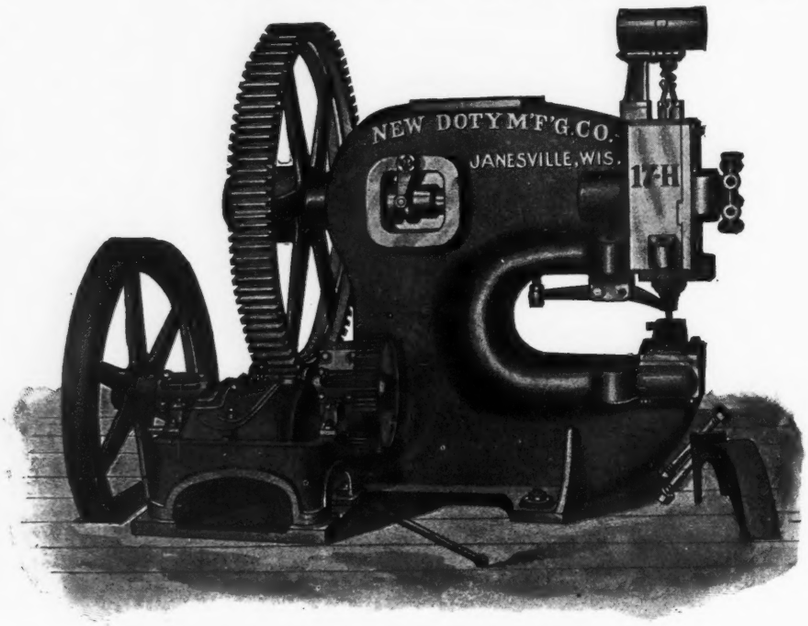
Punching and Shearing Machinery.

ALL SIZES. FOR ALL KINDS OF WORK.



PUNCH DRIVEN BY ELECTRIC MOTOR.

We show in engraving one of our standard machines fitted with electric motor for driving.

All machines, either standard or special, can be fitted with electric motors of any type or make to suit the purchaser.

Send for complete catalogue.

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Awaits the man who is willing to just plod along. He may hold his job, but the man who uses his spare time at home for learning the things that will make him more useful to his employer works into better jobs and earns more money. Perhaps you don't see how you can earn more. Write and let us tell you

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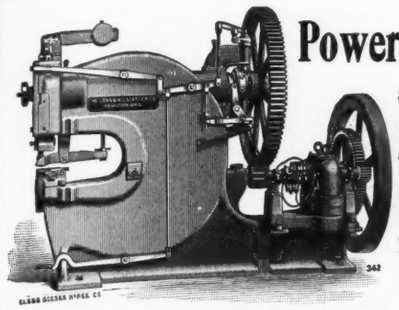
Our business is teaching by mail those subjects which will help you earn more in your own business. If you want to change your business, will teach you something you may like better. Our terms are low.

Write us today and let us tell you what we can do for you.

State what your business is and ask for our interesting Catalog No. 10.

The Consolidated Schools, 156 Fifth Avenue New York



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Belt, Steam and Electrically driven.

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Our machines are made in over 350 sizes and varieties.

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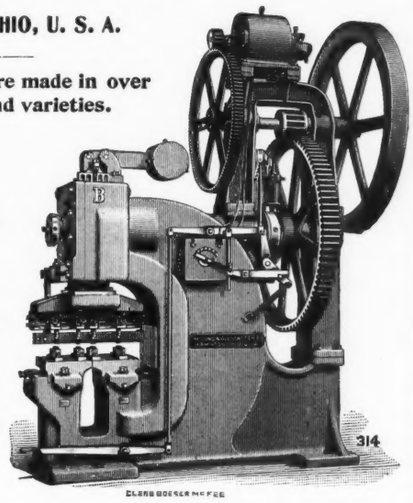

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SUMMER VENTILATION

Sizes from 18 inch to 120 inch. Capacities from 2000 to 175000 cubic feet per minute. Driven by belt or direct connected electric motor.

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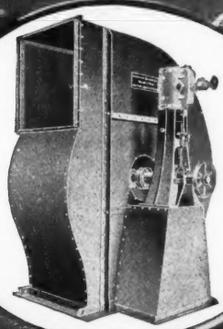
MECHANICAL DRAFT APPARATUS



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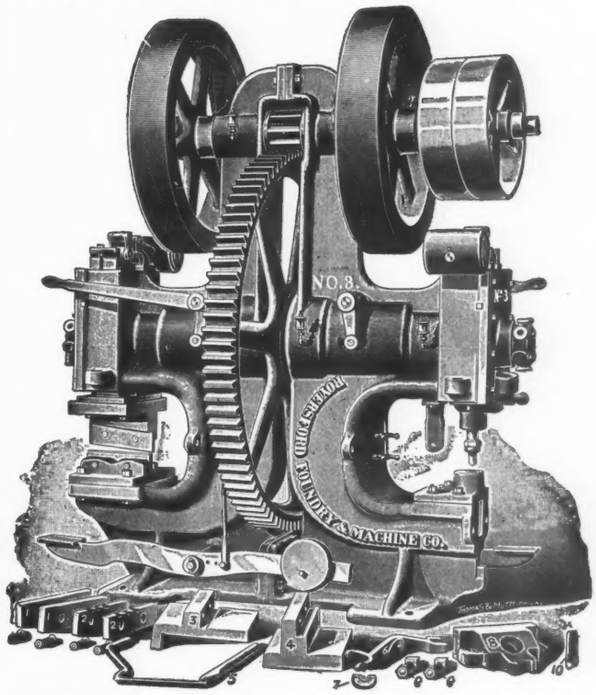
Do you need a good, servicable

PUNCH and SHEAR?

Then specify the ROYERSFORD



Built for service and fully guaranteed. Motor or Belt Drive Combined and Single. *Ask us about them.*

Royersford Foundry & Machine Co., Royersford Pa., U. S. A.

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"TOUGH AND HARDY AS A PINE KNOT".

BUILT WITH THE STRENGTH AND SIMPLICITY OF A MONKEY WRENCH UNDER

The Haeseler-Ingersoll Patents

It is not necessary to maintain a hospital for these tools.

Lungs not affected by foundry dust or dampness in the air. Give them a bath in keresone every Saturday and they are good for another week.

Strong, drop-forged valve with a new movement that cannot be disturbed by the blows of the hammer.

Simple means for taking up the slightest wear or looseness of the parts, with a strong key to keep them locked.

Safety trigger on riveting hammers to automatically lock the throttle so that piston or rivet set cannot be accidently discharged from cylinder.

These and other points of merit fully described in catalog.

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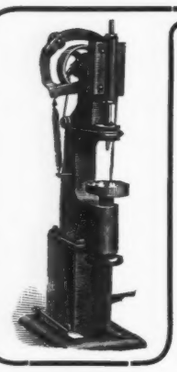

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to let the cost end of your business take care of itself—you know well enough the more you reduce expense the more profits increase.

If your product requires riveting

A Shuster Elastic Rotary Blow Riveting Machine

will drive both ends of the rivet at the same time and drive them right. Just the machine for hardware, mechanics' tools, bicycle chains, etc.

We build automatic labor saving machines of every description. Drop us a line.

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FORMERLY JOHN ADT & SON,

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3 AGAINST 10.

Makers of pneumatic tools usually guarantee to keep them in repair for a year. This guarantee costs other makers at least ten per cent. of sales,—*sometimes much more.*

Keller Pneumatic Tools

have cost us only THREE per cent. to keep them in repair for the past year. This means extra profit to us, of course—but think of the profit it means to the USERS!

It's the working time of a tool that counts.

KELLER TOOLS stand hard work without breaking down.

Write for our new catalogue, and booklet on the Care and Use of Pneumatic Tools.

Philadelphia Pneumatic Tool Co.

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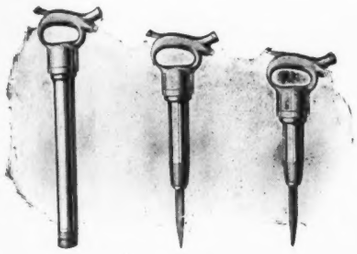

A Point of Importance

in Pneumatic Hammers and Chippers is durability. The Shepard Hammers are the very best working hammers yet produced, and they maintain their power and speed after long use with no decrease in efficiency.

We send them on trial to those who are interested.

We also make Pneumatic Motor Hoists, Compression Riveters, and Cranes.

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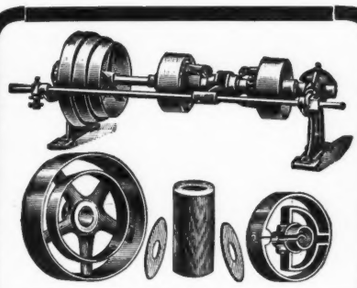

Stop Paying.

Oil on your loose pulleys only makes trouble, and you're never done paying.

ARGUTO OILLESS BEARINGS stop the trouble once for all, stop the oiling, stop the soaking of floors, belts and goods with oil, and stop the paying, too.

Do you know them?

Whose fault is it?

Stop paying for oil, and buy a postage stamp. A sample bearing free.

ARGUTO OILLESS BEARING CO.,
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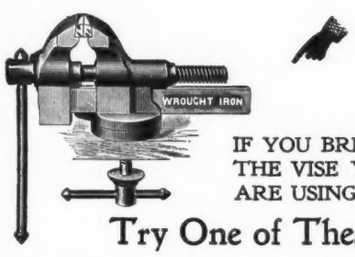

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Try One of These!

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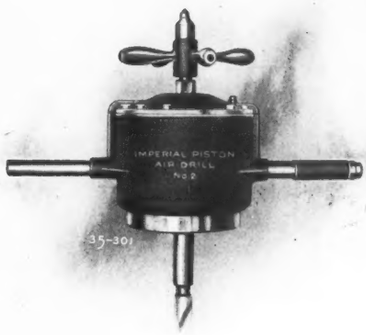

Imperial Pneumatic Tools

"Imperial" drills embody features in their design which distinguish them from all others upon the market. By prolonged service under various exacting conditions, they have proven themselves by far the most durable devices of their kind and, therefore, the most satisfactory to users. Their design permits of more liberal bearing surfaces than any other make affords. All moving parts revolve around fixed centers and are perfectly balanced and, consequently, there is absolutely no vibration. The fixed crank pin around which the cylinders revolve is provided with an admission port and exhaust port, and air is admitted to and exhausted from the cylinders successively as they revolve. The well-known advantages of the Corliss valve mechanism are thereby realized and the early cut-off results in unusual economy of the working fluid. There are no eccentrics or other delicate valve mechanism of any description, and the troubles and break-downs which invariably result from the use of such fragile parts are unknown with "Imperial" drills.

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will handle merchandise over any irregular area, and are most economically installed.

We also make Traveling and Gantry Cranes.

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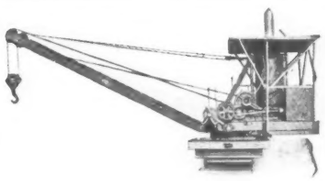

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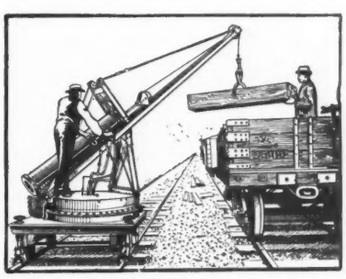

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Built to any specifications.

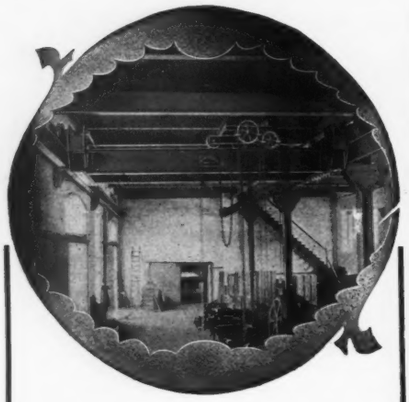
Standard capacity, 1,000 to 10,000 lbs.

Particularly adaptable for handling heavy materials in loading or unloading Freight Cars, Boats, or for Coaling Locomotives.

Mounted on car with standard track gauge.

The Garry Iron and Steel Co., Cleveland, Ohio.

General Machine and Structural Iron Work.



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that will stand an immense amount of wear. That are reliable. That require little head room and short end room. That lift and carry to their full capacity without danger of overstrain. That are controlled by one man from the floor

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Our two-piece cover is made in five sizes, turns in either direction and can be screwed or driven. Particularly convenient for loose pulleys, as once opened both hands are free.

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PNEUMATIC
POWERFUL BLOW
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For Light and Heavy Work Alike. Fastest Hammers in the market. Rivets driven by Cleveland Hammers fill the holes completely. Steam tight, and construction work perfect. Vibration minimum. Handles do not jar loose. Capacity for greatest range of work of any hammers made. Sent on trial test. If not satisfactory we pay charges both ways. ASK FOR CATALOG.
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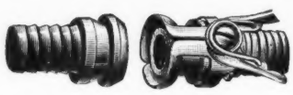
Uncouple? Grab!



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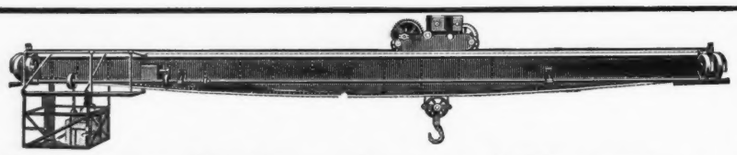
Henion & Hubbel, Agents, 61-69 N. Jefferson St., Chicago, Ill.



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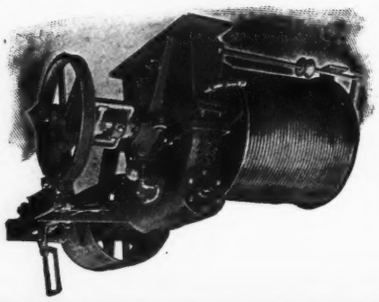

High-Grade Passenger and Freight Elevators a Specialty

We are among the oldest elevator manufacturers in the country and are giving special attention to this branch of business. We can ship Belted, Worm or Gear Machines from stock.

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Not merely the evolution of machine designs which facilitate the application of motor so that both machine and motor can operate at highest efficiency.

Conditions may permit of the conversion of power-wasteful *belt-driven* machines into orthodox, well-behaved, readily controlled, economical, efficient *motor-driven* machines.

Tell us of the conditions in your plant and we will advise of the practicability of equipping your machine tools for motor drive.

The lathe illustrated is described in our Leaflet No. 20104.

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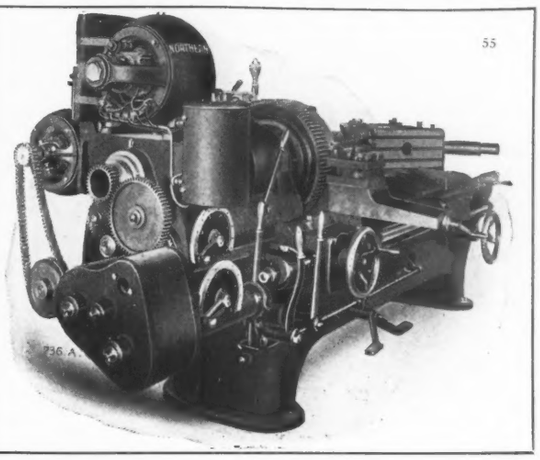

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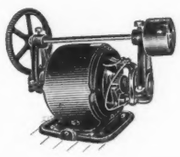

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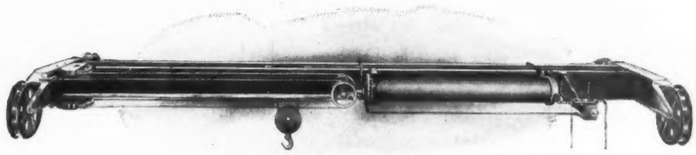

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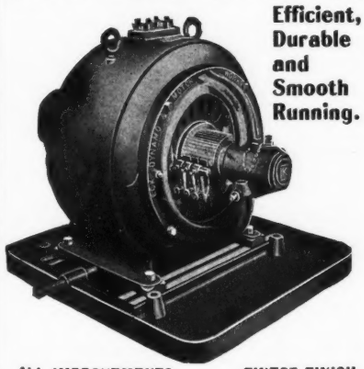

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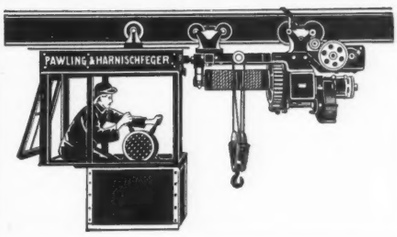

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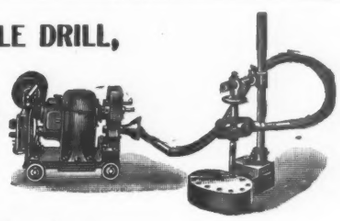

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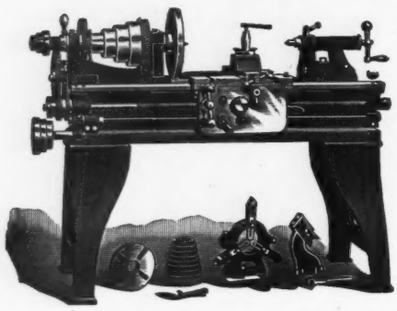

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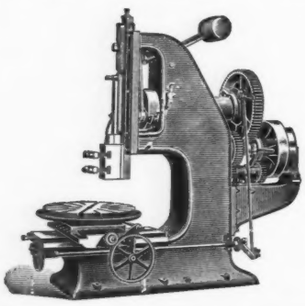

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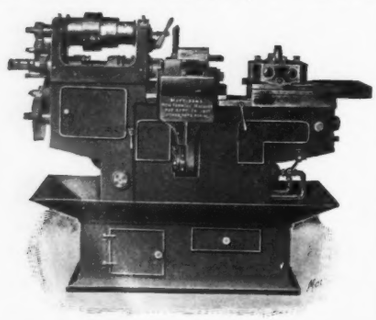

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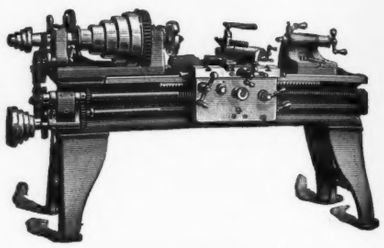

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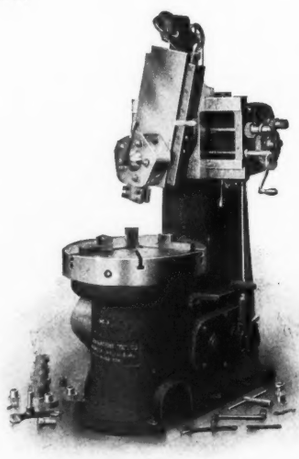

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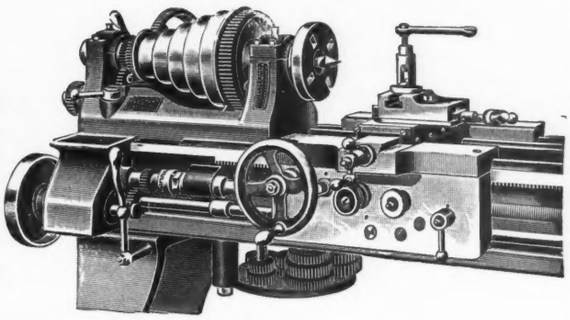

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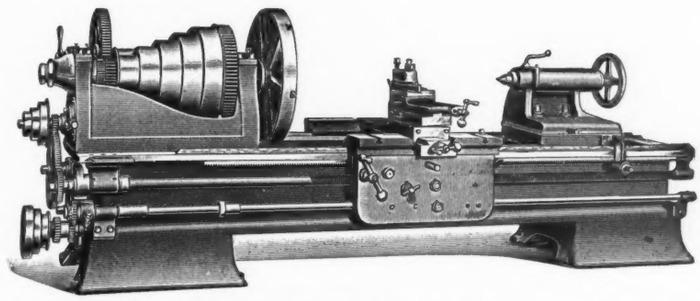

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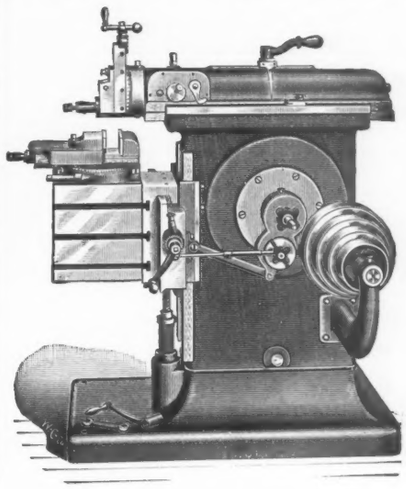

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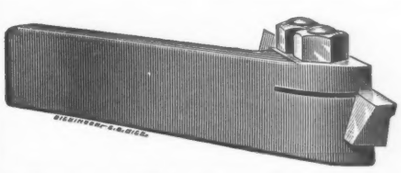

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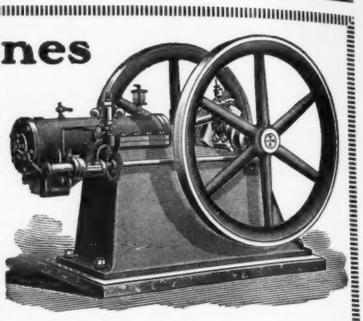

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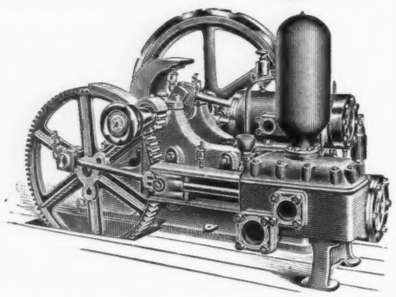

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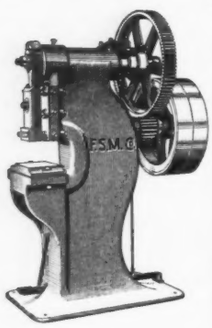

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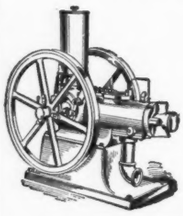

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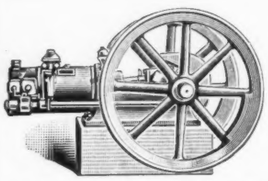

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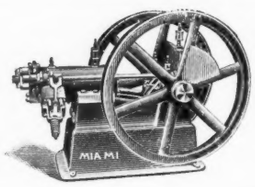

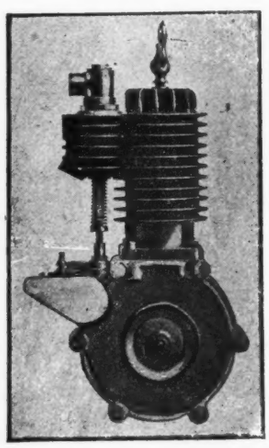

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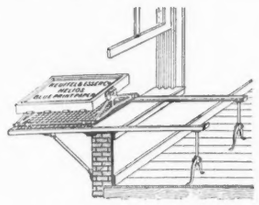

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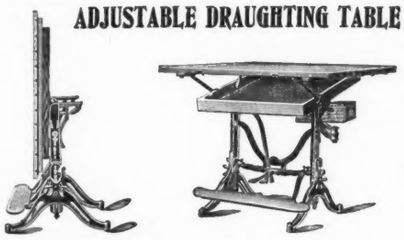

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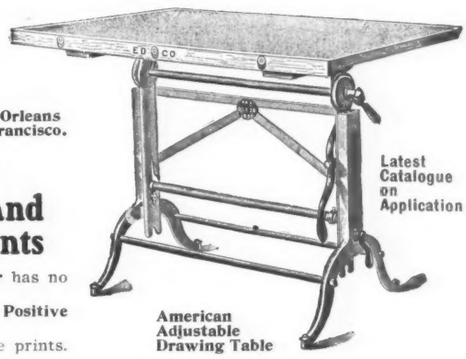

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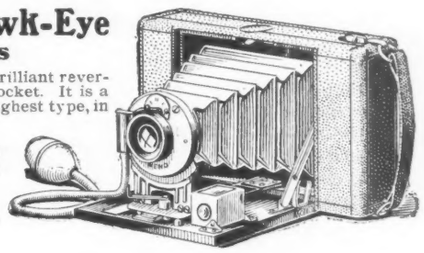

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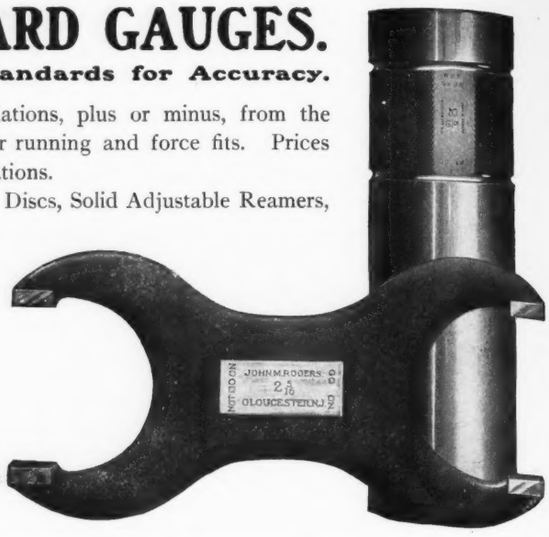

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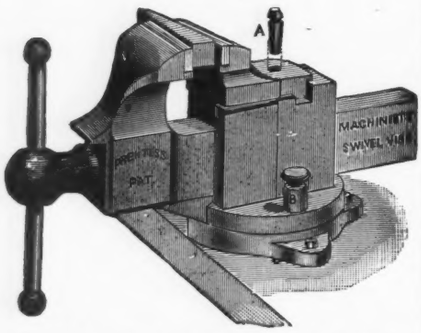

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with self-adjusting jaw that is as strong and durable as any solid jaw, and a Swivel Bottom that gives any desired adjustment to right or left, and is solid and firm at any angle. We make all sorts of good vises, and have been leaders in this line for twenty years. Send for catalogue and price list,

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is simple in construction, rapid in operation, has ample power—15 to 50 tons pressure—and can be adapted to a wide range of work outside the routine operations of forcing in pins and bushings, bending, broaching, forming and like work. Nothing to get out of order, convenient to operate; made in three sizes.

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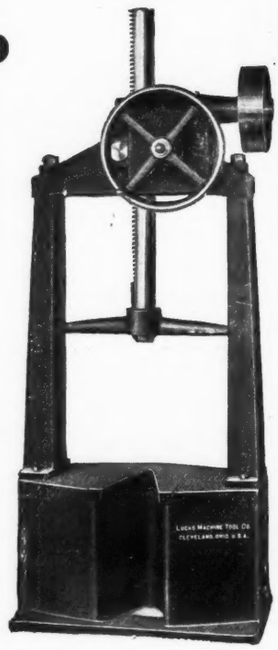

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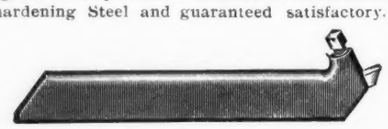
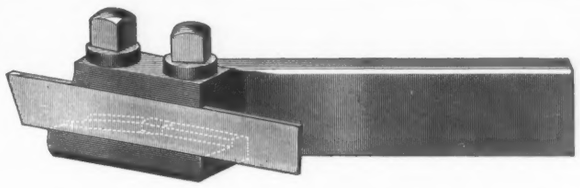


Tools with Good Constitutions

are needed to stand the wear and tear of constant work and to permit the greatest economy in the use of the new self-hardening steels.

The FAIRBANKS OFFSET CUTTING-OFF TOOL is a lathe tool with a constitution that will defy the most severe service, and give the fullest satisfaction.



The holder is steel, drop forged and hardened; the cutters, a special grade of self-hardening steel, rolled beveled on both sides to give the proper clearance and insure a clean cut. Provided with renewable steel cap; blade requires grinding on the cutting edge only. A strong, durable, efficient tool.

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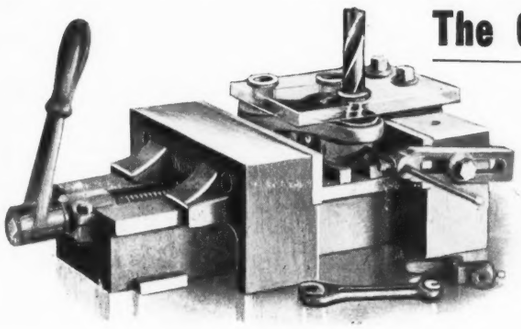

It is not only a good vise for plain drilling but a little gold mine when it comes to duplicate and jig drilling. You know how much time is wasted setting each piece of work on a duplicate job? With the Universal Jig Vise if the first piece is carefully set the others can be clamped in exact position without trouble and each drilled precisely like its fellow. Then the saving on special jigs—we know at least one case where this saving on a single job amounted to more than the cost of three vises, and by using the vise as a base on which to fasten plates with several bushings its range of usefulness is greatly extended.

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Canadian Makers: The Imperial Vise Co., Galt, Ontario. European Agents: Selig, Sonnenthal & Co., 85 Queen Victoria St., London, England

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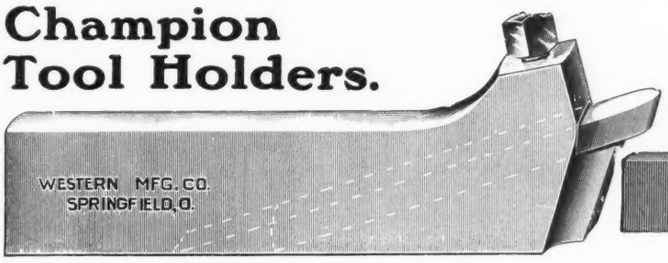
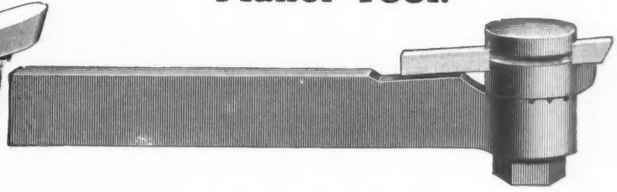


Planer Tool.



Champion Tool Holders use steel the most economically and tax the capacity of Modern Lathes.

Our Catalog will tell you all about the different styles and sizes we make.

The Western Manufacturing Company, Springfield, O.

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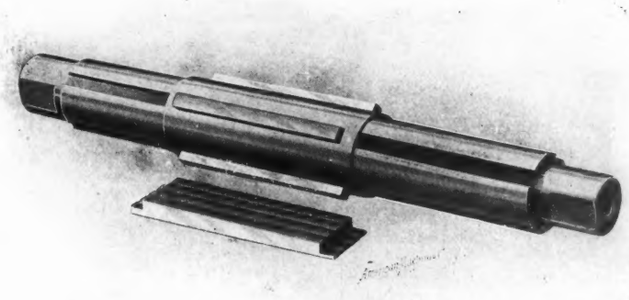

in time saving or money saving you're not interested in Nicholson Expanding Mandrels, because those are their strong points. Nine of the expanding mandrels will do you more good than a hundred of the solid kind; they are always ready too; take anything from one to seven inch holes, hold the work right—all right every way. We'll gladly tell you more about them.

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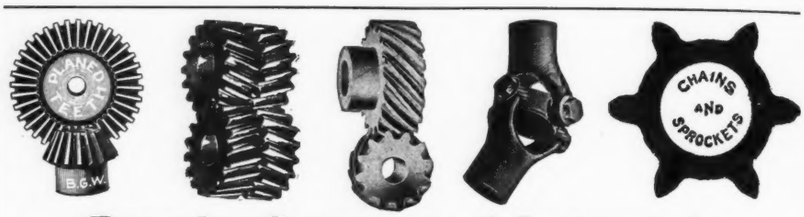

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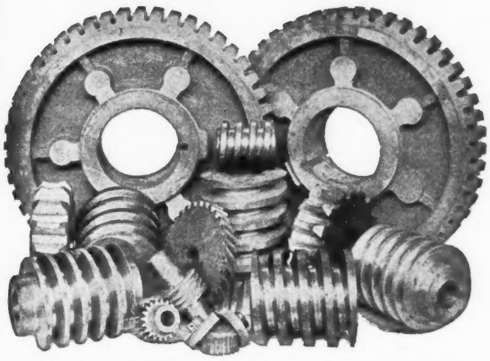

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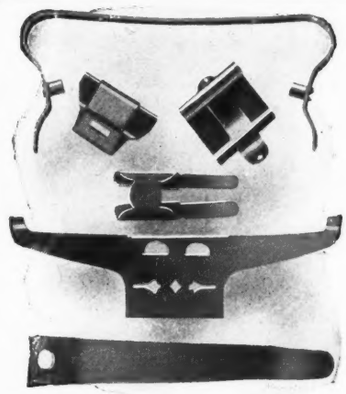

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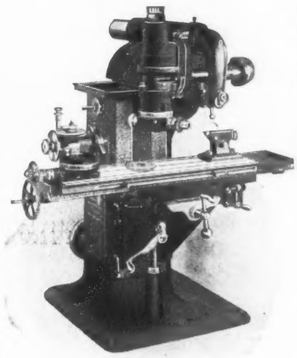

with full universal centers and sub-head. The most complete universal milling machine on the market. Below we give an opinion from a prominent machine tool maker who has one of these complete machines in use.

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Yours truly,
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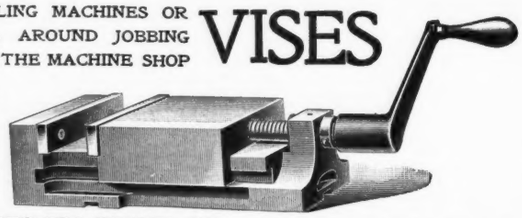

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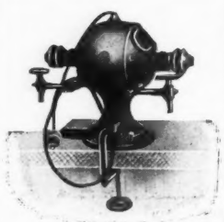

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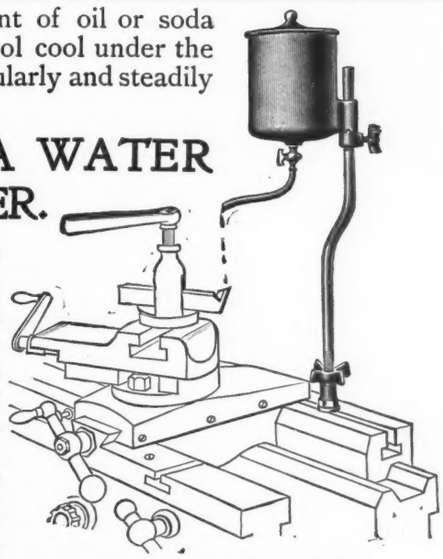

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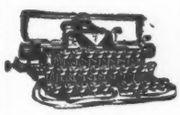

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50 lathes, all makes, 12 to 20 inches swing, any length in bed.
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600 lb. P. & W. drop hammer.
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Heavy double end punch and shear cap, ½ x ¾ in.
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72" Double Driving Wheel Bement.
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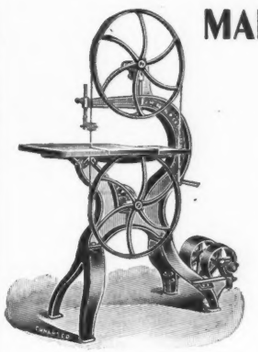

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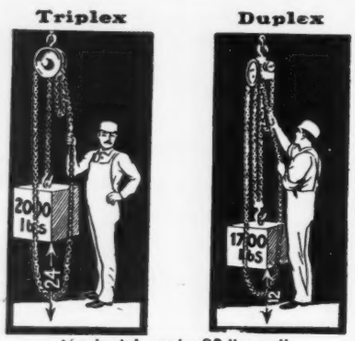

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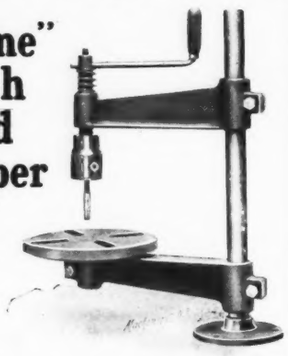

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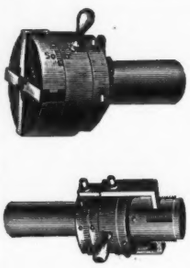

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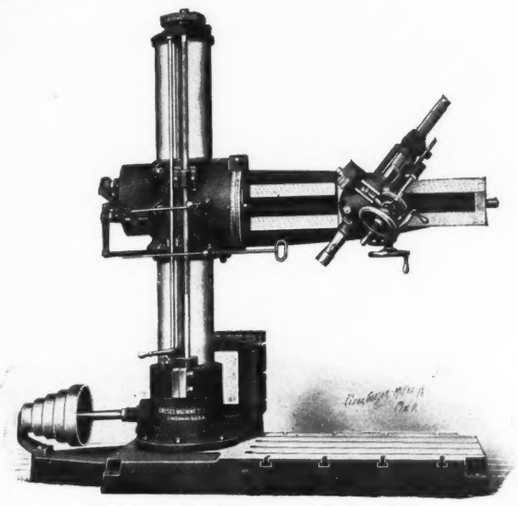

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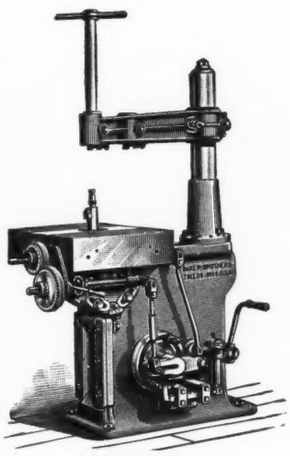

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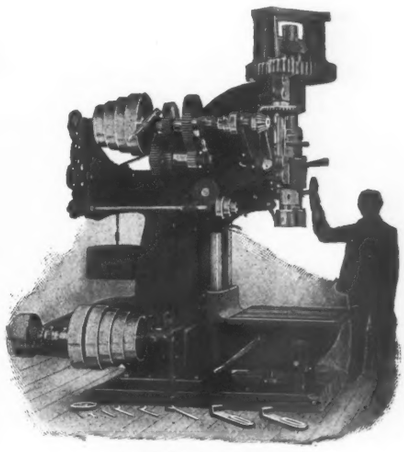

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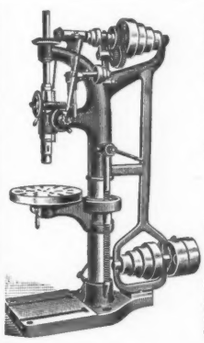

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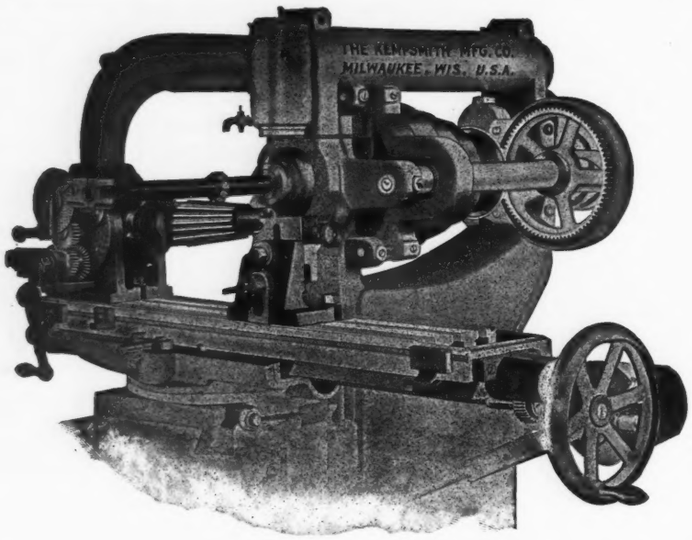

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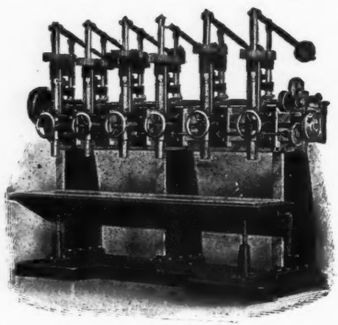

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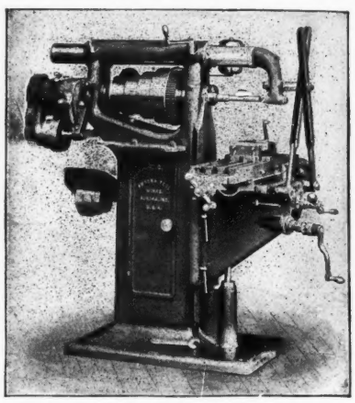

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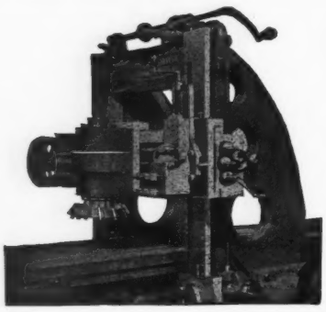

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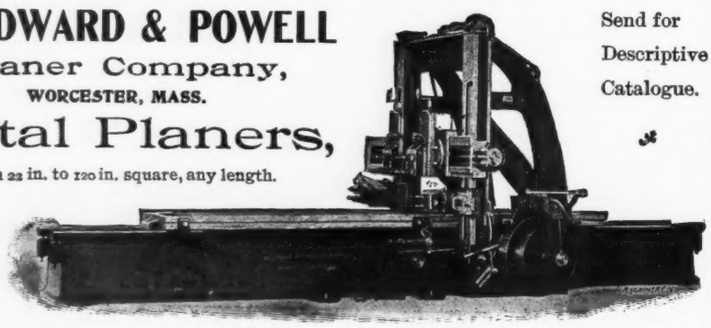

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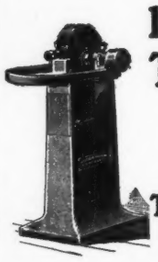

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Tucker Machine Co.
MANUFACTURERS.
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One Setting of the Work

only is required for the operations of drilling, reaming, counterboring and tapping with

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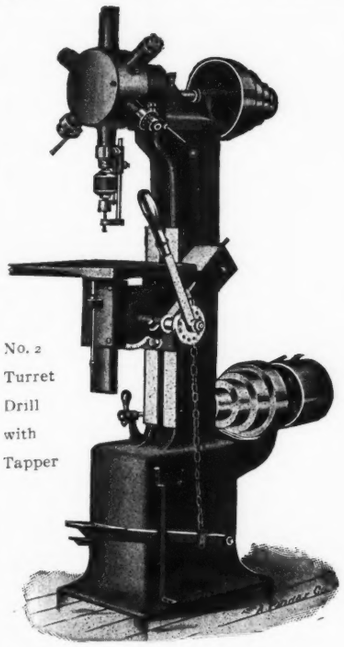

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Accurate and rapid in operation.
Time and labor savers.
Made with from four to twelve spindles.

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Combination of

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and

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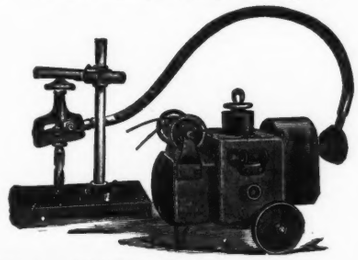
Portable Drilling, Tapping, Reaming, Etc.



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NO PLATE TOO LARGE OR TOO SMALL.

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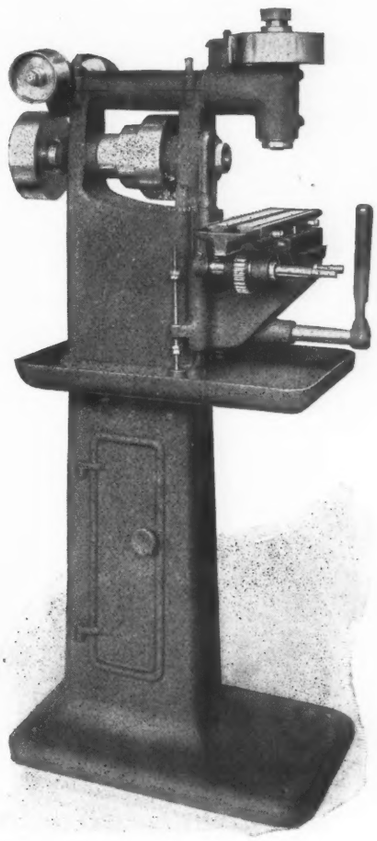
The No. 2 Chicago Hand Miller

Notice the Vertical Spindle



For finishing a great number of small parts in the least time at the lowest cost, this is the machine to use.

Vertical spindle and overhanging arm are interchangeable and both are supplied with draw-in collet mechanism.

Table 4 in. by 12½ in. Self oiling bearings.

Quick-acting vise a new improvement.

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For Machine Shops and Foundries, Bolt Works, Etc.

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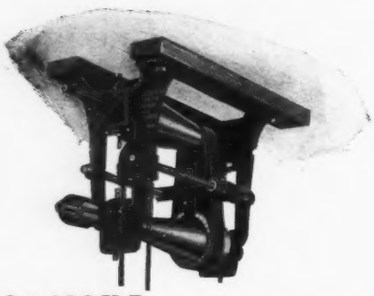

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The

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Builders of **The "Moore & White" Friction Clutch**

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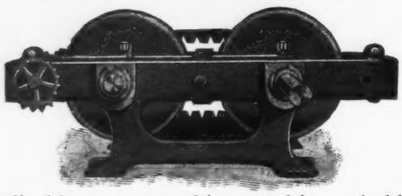

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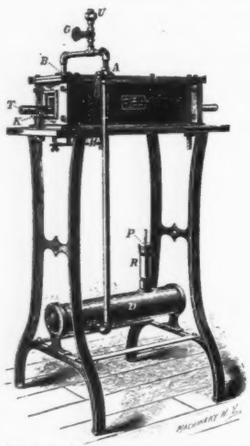

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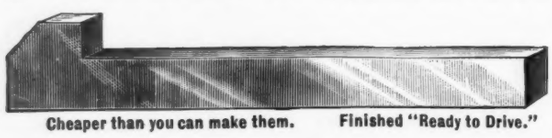

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All sizes carried in stock. Write for discounts.

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The proper way to test Hack Saw Blades is to cut off pieces from the same bar of steel, changing the blades to be tested on each alternate cut. Keep an accurate record of the time consumed by each blade in performing the work and the number of cuts each blade makes. If the weight or pressure on the blade is changed it should be made so as to affect both saws alike. This is the kind of test we solicit for the

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All we ask is a fair trial and if we cannot then convince even the most hardened unbeliever that our blades are all we claim for them—we have nothing more to say. Your dealer will furnish them on your order. Send for circulars and prices.

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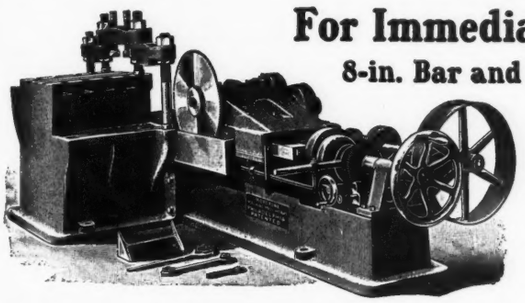

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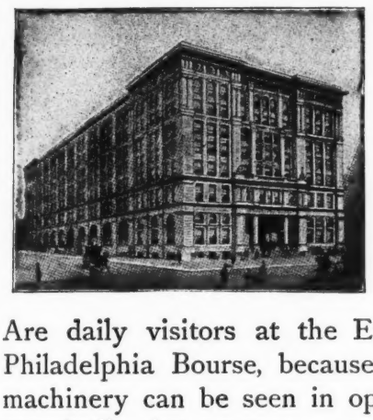

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Made of the best tool steel and of proper temper.

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JUST THE HANDIEST THING!

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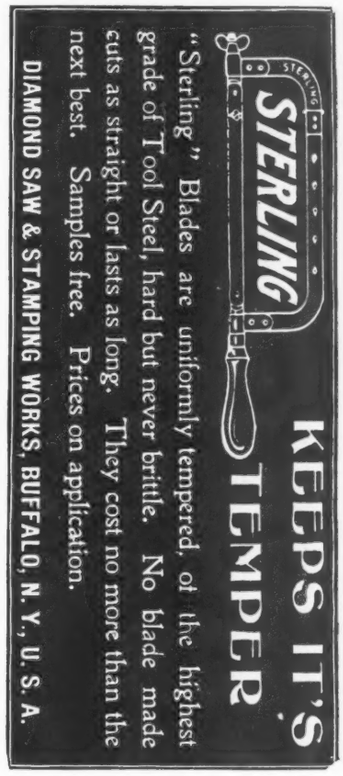

"Sterling" Blades are uniformly tempered, of the highest grade of Tool Steel, hard but never brittle. No blade made cuts as straight or lasts as long. They cost no more than the next best. Samples free. Prices on application.

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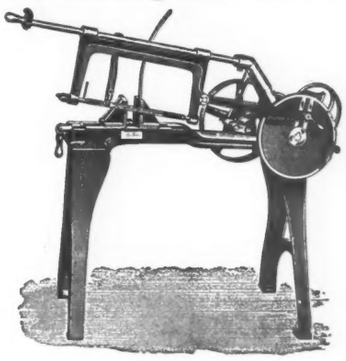
The Draw-Cut Machine Saw

is looking for trouble



No. 1, 6"x6'.

in the shape of something in the line of Cold Metal it can't cut. Been sawing for over two years and hasn't found it yet. Will go through unannealed tool steel without a grunt, never snap a blade, come through in a direct line from where it started, and consume least power and time doing it.
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Descriptive circular, giving all details on request.

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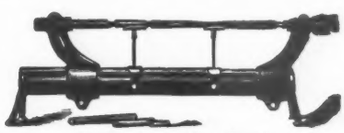

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Measuring screw, 10, 16 or 20 threads to the inch, graduated to read thousandths or 32ds without calculation.

The only Micrometer that will not lose its accuracy by wear.

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For Dynamos, Trip Hammers or other Heavy Work.

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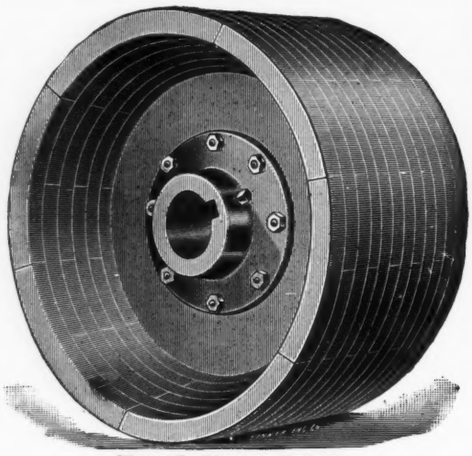

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Saginaw Manufacturing Company,

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SALES AGENCIES IN ALL THE PRINCIPAL CITIES IN THE WORLD.

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A Vise for Machinists

that meets all the requirements of the tool maker, and metal workers in general. Constructed so it can be used in any desired position. Supplied with one set of jaws to hold all classes of round work, one set to hold taper, one for copper work and one to hold any size of ring. Also supplied with rough jaws for cast iron work, smooth jaws for finished work, and pipe jaws.

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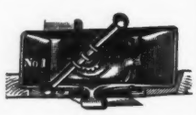

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Fit up your machines with the

U. S. STANDARD PUNCHES

The Best System on Earth for

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BALTIMORE, MD.
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IRON CASTINGS 30,000 LBS. TENSILE STRENGTH

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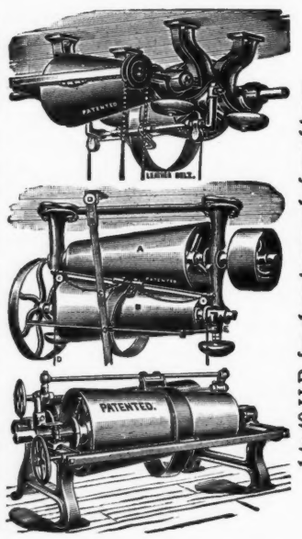

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Seamless Steel Tubing

Adopted for an infinite variety of uses in mechanical and engineering lines.

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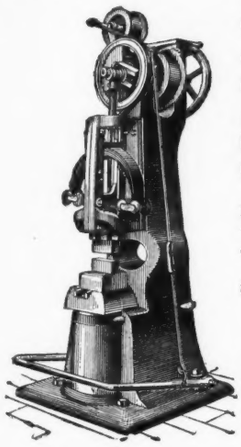
Scranton Power Hammers



COST LESS than any other hammer that will produce an **EQUAL AMOUNT OF WORK.**

By our construction we avoid breakdowns.

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Steam Hammers
AND
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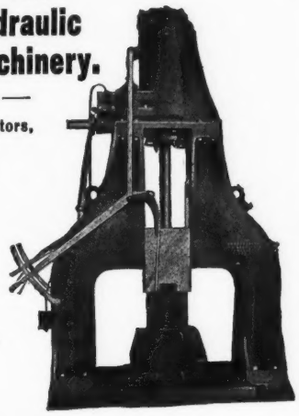
Accumulators, Riveters, Cranes, Presses.



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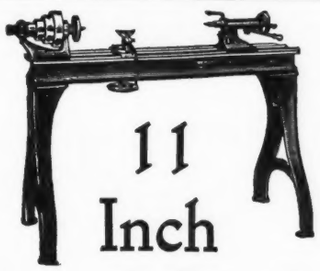

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WITH

Combination Wheel and Lever Tailstock.

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NEW PATENT WHIP. Patent FRICTION PULLEYS—none better Manufactured by
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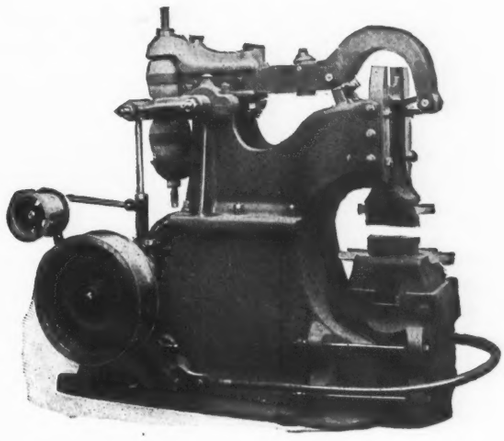

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Are made with heads weighing 15 to 500 pounds. Each contains ⅓ to ½ more material than those of any other make of the same rating.

Their anvil blocks weigh nearly or quite double those of other hammers.

Their output is guaranteed 25 per cent. greater than is possible with other hammers of same rating or no sale.

More Bradley Hammers are sold each year than all other power hammers combined.

We make four styles of Belt Hammers and a line of Heating Forges.

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Simple, Efficient and
Beaudry & Co.,
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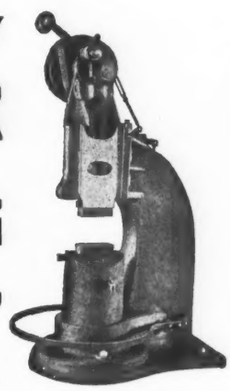

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Durable, Economical.

Chas. Churchill & Co., London, E. C., England, Agents for Great Britian.

DROP PRESSES

For All Purposes Our Specialty.

MINER & PECK MANUFACTURING CO.,
PROPRIETORS OF
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All Wheels Look Alike

to some people, but the man who wants the BEST Emery Wheel and KNOWS it when he sees it always orders a STERLING WHEEL.

Write us for prices.

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A THOROUGH TEST

of material is made in the vitrified process by which the

"ABRASIVE"
EMERY WHEEL

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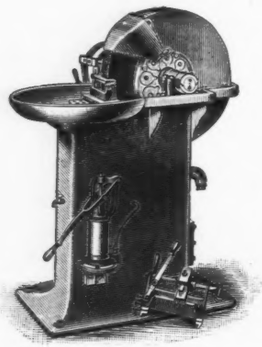


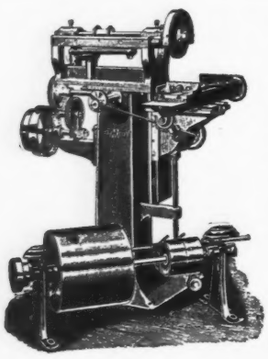
We Want You

to LOOK at this AIR PUMP for supplying water to the EMERY WHEEL.

Patented Aug. 19, 1902.
Four Sizes, 20"—26"—36"—42".

BOTH MOTOR and BELT DRIVEN
Send for full description and catalogue.
Emery Wheels and Grinding Machinery.
Knife Grinders a specialty.

THE BRIDGEPORT SAFETY EMERY WHEEL CO., Inc., Bridgeport, Conn., U. S. A.



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Our No. 1 Surface Grinder is especially adapted for grinding and finishing dies, punches and hardened parts of machinery, as it produces absolutely true surfaces. Grinds 8 inches wide and 18 inches long using an 8 inch wheel, and will take a piece of work 12 inches high. Made in two sizes.

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your work and favor—Is what we do on Special Mechanisms of all kinds. } **TRY US.**

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Tool Post Grinders. Counting Wheels.

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Carborundum

cuts the price of grinding in half. It is the hardest the sharpest the longest lasting abrasive on earth. Made into grinding wheels of all sizes and shapes—and into sharpening stones, paper and cloth and powders and grains for polishing.

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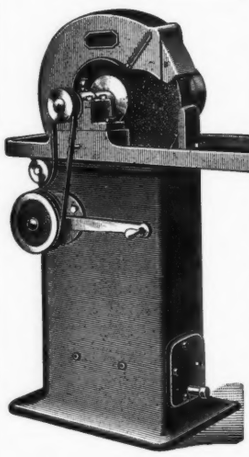

20-inch Water Tool Grinder.

Base on floor 16 in. x 24 in.

Emery Wheel, 20 in. x 2½ in.

Weight 600 lbs.

The pump on this grinder is entirely above the water, cannot leak, requires no packing, and can be stopped and started at will.

Catalogue N shows our full line of Emery Wheels and Emery Wheel Machinery. Mailed free.

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COMPARE OUR PRICES AND SAMPLES.

HAMPDEN CORUNDUM WHEEL COMPANY,
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If Your Grinding Wheel is a NORTON it's right

If you are not obtaining the best results from your Grinding Department—better write us about it.

We build Bench and Floor Grinding Machinery and our experience and success in adapting the right wheel to your own particular work has made

"NORTON" EMERY, CORUNDUM AND ALUNDUM WHEELS

known in every land under the sun where iron and steel are used.

Agents everywhere and stocks of "Norton Wheels" are found in every large city in the world.

Our facilities for manufacturing are unequalled. Your order for a single wheel will have as careful attention as that of the largest purchaser.

We can help you and we know it. Every wheel tested. Only the best and purest of natural and artificial abrasives are used in the manufacture of our vitrified, elastic or silicate wheels.

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Craig Corundum Wheels

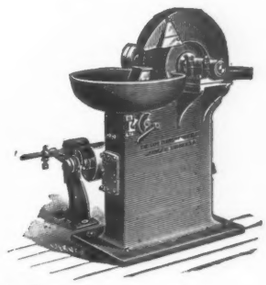
Fifty per cent more efficient than any other abrasive wheel. Fast cutting, long wearing, will not glaze, will not draw the temper of the tool being ground.

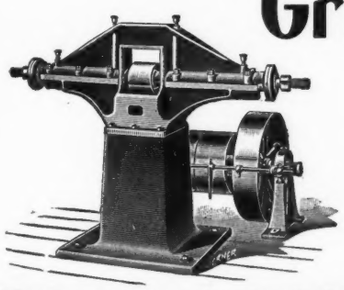
A new wheel made from new material—Craig Mine Crystal Corundum—but made by the old process.

Write for our new catalogue.

Vitrified Wheel Co., Westfield, Mass.

Emery Wheels and Grinding Machinery





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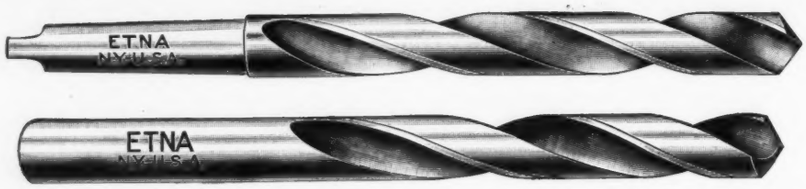
ETNA TWIST DRILLS.

Highest Quality Guaranteed.



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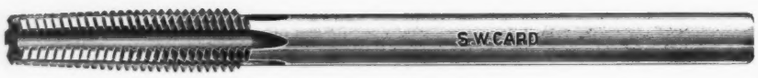
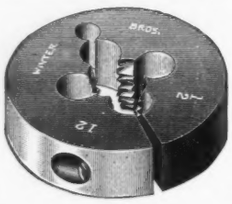
No Taps Like Card's Taps



We manufacture a complete line of these tools and guarantee them to suit *particular people.* All styles and sizes. Get our catalogue of Screw Cutting Tools.

S. W. Card Mfg. Co., Mansfield, Mass.

At the Sign of the Thistle



Let us send you price list of our

Taps, Dies and Die Stocks

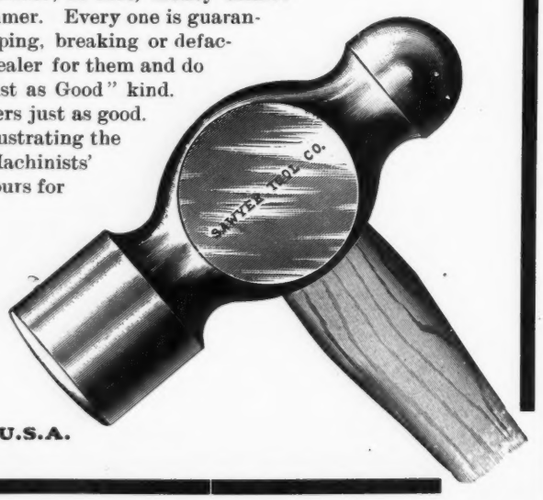
of the well-known Thistle Brand. Finest workmanship and material guaranteed. Taps and dies for brass work a specialty. Special taps, dies, collets, etc., to order.

WINTER BROS. COMPANY, Wrentham, Mass., U. S. A.

Our Name on a Tool

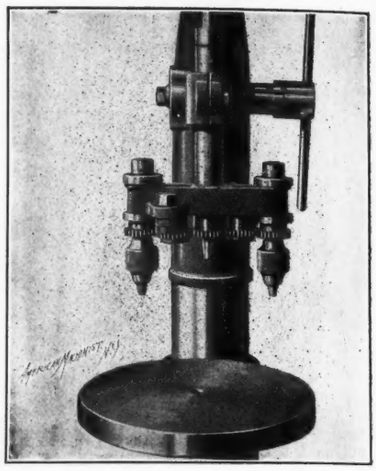
Is a GUARANTEE that it is the best of its kind made. This Applies well to Our HAMMERS.

They are made of the finest tool steel obtainable for the purpose, drop forged, tempered to just the right degree of hardness, highly polished to give the desired appearance, hung just right with selected handles; in fact, money cannot buy a better hammer. Every one is guaranteed against chipping, breaking or defacing. Ask your dealer for them and do not take the "Just as Good" kind. There are no others just as good. Our catalogue, illustrating the finest line of Machinists' Tools made, is yours for the asking.



Sawyer Tool Mfg. Company,

Fitchburg, Mass., U.S.A.



WILL DRILL THREE HOLES AT ONCE. Outside Spindle will adjust out and in. Made for 13 inch and 20 inch Drills by

FRANCIS REED CO.

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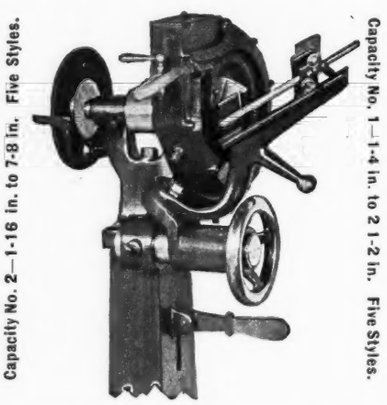
Absolutely no Spatter

Floods the drill with water. Very rapid and accurate. Simple, efficient.



Write for our catalog describing the 30 VARIETIES WORCESTER DRILL GRINDERS.

THE WASHBURN SHOPS,

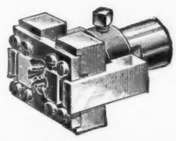
Worcester Polytechnic Institute,

Worcester, Mass., U. S. A.

39 Cortlandt Street, New York. 154 Lake Street, Chicago.

ERRINGTON TAPPING AND DIE CHUCKS.

Original, most highly improved; consequently simple, durable, low priced.

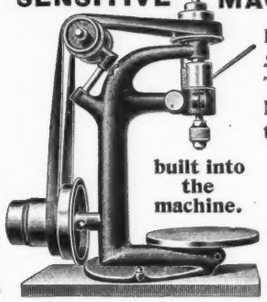


ADJUSTABLE OPENING DIE.

	Std.	Pipe.
No. 1 Threads to	⅝ inch.....	⅜ inch.
No. 2 Threads to 1	inch.....	¾ inch
No. 3 Threads to 1½	inch.....	1 inch.

Opens and Closes While Rotating.

EXTRA SENSITIVE TAPPING MACHINE



For very Small Taps, No. 1 up to ¼ in.

built into the machine.

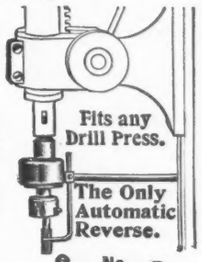
Auto-Reverse Tapping Chuck.

Drives tap in, stops automatically at bottom of hole; backs tap out (quick return) without stopping or reversing drill press spindle.

No. 00 taps to ¾ in. No. 3 taps to 1¼ in.
No. 0 taps to ⅝ in. No. 4 taps to 1½ in.
No. 1 taps to ¾ in. No. 5 taps to 2 in.
No. 2 taps to 1 in.

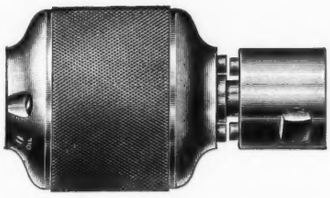
DRILLS, TAPS, SETS STUDS IN LINE.

NO STOPPING, REVERSING, MOVING WORK CHANGING SPEED.



GREAT BRITAIN, Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. FRANCE, Edgar Bloxham, 17 Rue des Petites Ecuries, Paris.
GERMANY, Arthur Kayser, Steinmetz Strasse 3, Berlin, W. SWITZERLAND, American Import Machinery Office, Zurich and Chaux-du-Fonds.

The "Ideal" Reversing Tap Holder



Entirely complete in itself. Taps right or left hand threads equally well; very sensitive and a great saver of taps. Made in two sizes—No. 1, 0 to 7-16". No. 2 0 to 1 1-4".

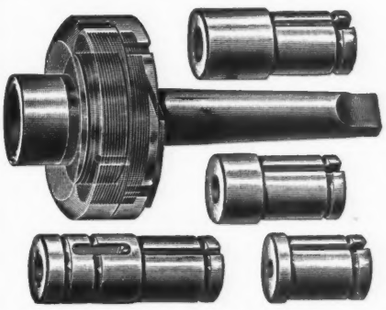
Circular on request.

IDEAL MACHINE CO.
HARTFORD, CONN.

The Blount Grinders

These grinding machines are made from new and improved patterns and are of new design. All material and workmanship is first-class. All arbors are ground and run in self oiling bearings. Built in 6 sizes for 8 in. to 20 in. wheels. For other information get our circulars, our prices will be of interest to you.

J. G. BLOUNT & CO.
Pleasant Ave. **Everett, Mass., U. S. A.**



THE

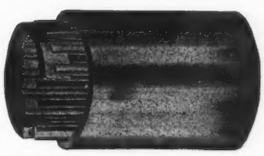
Safety Drill & Tap Holder

is the only attachment for the purpose that gives universal satisfaction, and is

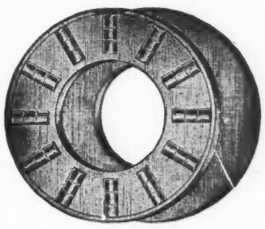
UNEQUALLED for Efficiency, Convenience, Rapidity, Accuracy and Simplicity.

Nothing to Break or get out of Order. Made in 4 sizes, covering from 0 to 2½ in. diameter.

The Beaman & Smith Co., Providence, R. I., U. S. A.



Journal Roller Bearing.



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Standard Roller Bearing Company

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SAVE POWER AND OIL

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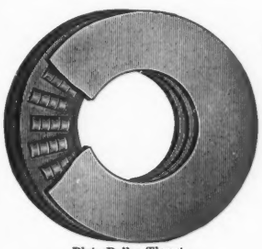

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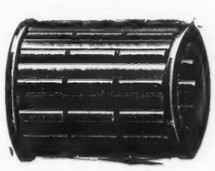

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Antifriction Bearings of all Descriptions.

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The Ball Bearing Co.

(Formerly of Boston.)

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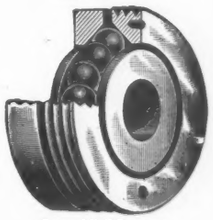
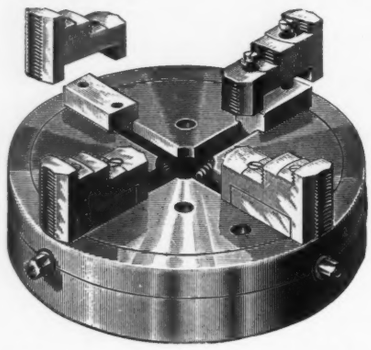


Grooved Ball Bearing.

Horton Combination Lathe Chuck



with Reversible Jaws.

Practically as strong as a solid jaw; allows a continuous bite at either end of jaw, the same as a solid jaw, thus insuring greater strength and accuracy than any other chuck of this style.

WE MAKE A FULL LINE OF CHUCKS FOR ALL PURPOSES. Send for Catalogue.

The E. Horton & Son Company, WINDSOR LOCKS, CONN.

Without Equal.

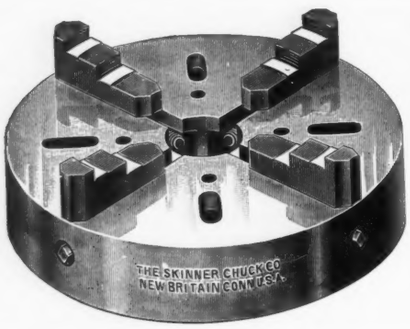
Our National Drill Chuck

has the most powerful grip of any drill chuck on the market. Absolute positive drive. Strong, durable, made of steel.

We make a full line of chucks. Let us send you our catalogue.

Oneida National Chuck Co.,
ONEIDA, N. Y., U. S. A.

English Representative: Alfred A. Jones, Church Gate, Leicester England.



Independent Lathe Chuck.
1901 Pattern.

THIS line of Chucks is made with flush screw heads, reversible jaws, and other improvements suggested by years of practical experience in manufacturing chucks. They are strong, durable and so nicely balanced that they may be run at any desired speed without fear of injury to the finest machinery. Workmanship and material the best.

Our latest catalogue sent on request.

The Skinner Chuck Co.,
New Britain, Conn. U. S. A.
NEW YORK OFFICE, 94 READE STREET.

If you want the best Lathe and Drill

CHUCKS

BUY WESTCOTT'S.

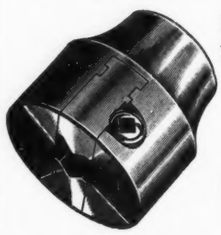
Strongest Grip, Greatest Capacity and Durability, Cheap and Accurate.
WESTCOTT CHUCK CO., Oneida, N. Y., U. S. A.
Ask for catalogue in English, French, Spanish or German.
FIRST PRIZE AT COLUMBIAN EXPOSITION, 1893.

As to Chucks—

The "*Sweetland*" has so many good points, it requires a whole book to describe them. We shall be pleased to send you the book. Tell us what you want and we will prove that we can send it to you.

The Hoggson & Pettis Mfg. Co.
New Haven, Conn., U. S. A.

No Weak Places



In the Reid Drill Chuck.

One part is as strong as another. Outwears any other kind of chuck. Made right and sold at the right price. Circulars and price lists mailed on request.

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New Haven, Conn.

Special Work...

We are equipped to make any desired machine complete from the drawings, including the patterns and brass or iron castings. Our men are experienced on high grade duplicate machine work, and we can handle any order of reasonable size, promptly and economically.

Pulley Moulding Machines Handling Pulleys up to 48" diameter.

American Foundry and Machine Co.
HANOVER, YORK COUNTY, PA.

DRILL CHUCKS.

For Sale by
De Fries & Co., Dusseldorf, Germany.
Charles Churchill & Co., Ltd. London, Eng.

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MANUFACTURERS
Wilmington, Del., U. S. A.

"An Industrial Problem"

Mailed upon receipt of 10 cents.

By W. S. ROGERS.

Keep time with Our Machine.

Industrial Timekeeping and Cost System,
BANTAM, CONN.

Almond Drill Chuck.

Sold at all machinists' supply stores.

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Independent 2 jaw.
Independent 4 jaw.
Universal 2 jaw.
Universal 3 jaw.
Universal 4 jaw.

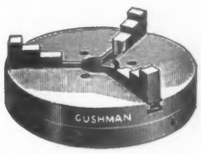
Combination 3 jaw.
Combination 4 jaw.
Drill Chucks.
Face Plate jaws.
Centering Chucks.

SPECIAL CHUCKS.

CUSHMAN CHUCKS.

A complete line, all styles and sizes.
Send for 1903 Catalogue.

THE CUSHMAN CHUCK COMPANY.
HARTFORD, CONNECTICUT, U. S. A.



A SEVERE TEST OF

both material and principle of design is bound to result to every tool engaged in the present-day methods of crowding machines regardless of their rated capacity. Yet the demand for

The Pratt Chuck

is ever increasing. Why—because they never fail when it comes to the heavy straining work that has a tendency to pull the machine out of alignment. The kind that snaps drills and puts the ordinary chuck out of business never disturbs the "PRATT" because they're built to meet emergencies. Ever hear of their **PATENTED EQUALIZING DRIVER?**

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PRATT CHUCK COMPANY, Frankfort, New York.

Fine Reamers—Green River Brand.

Taps, Dies, Screw Plates,
Bolt Cutters and
Drilling Machines.

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Mfg. Company,
GREENFIELD, MASS.,
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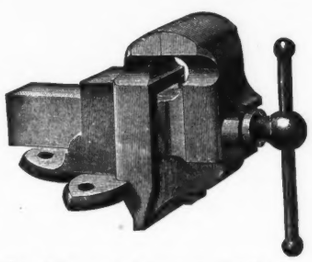

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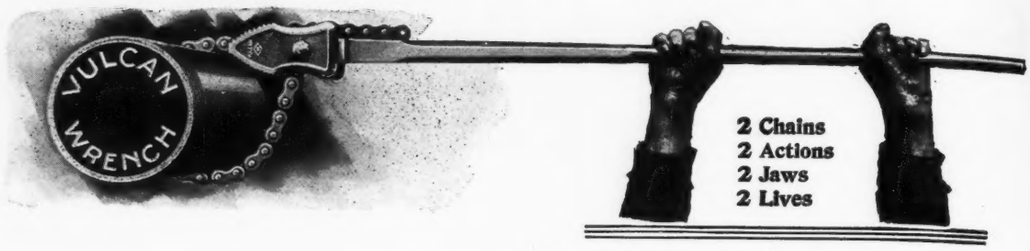
We Claim to Make the Best Line of Vises on the Market.

The Vise shown in cut is our "standard" pattern, made of first-class material so distributed as to produce the greatest strength and durability, the front jaw being reinforced from beneath. It is extra fitted, has jaws of best tempered steel, is convenient in use, and one of its greatest recommendations is the entire absence of complicated mechanism. Unquestionably the best solid nut screw vise made for machinists' use.

Athol Machine Company, Athol Massachusetts, U. S. A.

"Says he"—

"you've got my hands and feet in your advertising pictures. Now I like the "Vulcan" tongs so much that if you tried to show my heart in same way you'd have to hire a ten-acre press to do the printing.



And if all pipe-men knew the "Vulcan" as well as I do they'd help to hire the press, too."

J. H. Williams & Co.
DROP-FORGINGS ONLY.
Brooklyn, New York.

Trimo Pipe Wrench

Drop forged from bar steel; interchangeable in all parts. Inserted jaw in handle, which is removable.

TRIMO PIPE CUTTER.

3 sizes; cut pipe from ⅛ in. to 3 inches. Convertible into a three wheel cutter by substituting wheels for the two rolls.

"TRIMO" BULL DOG CHAIN WRENCH.

7 sizes; capacity ⅛ in. to 12 in. pipe. This is the strongest wrench made and it will stand rough using. Chain will not drop out when socket, into which the chain is placed while in use, is on the under side.

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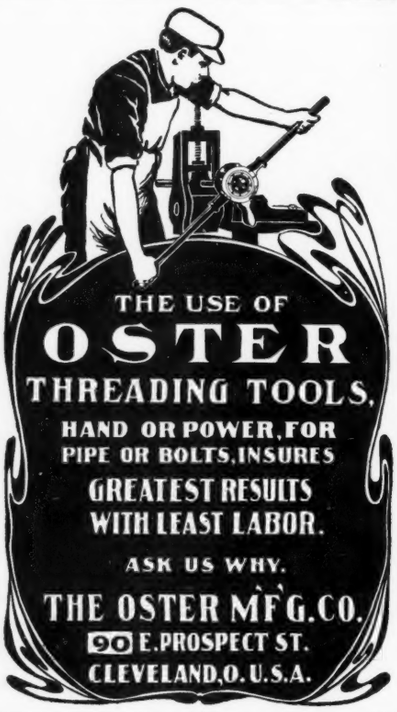
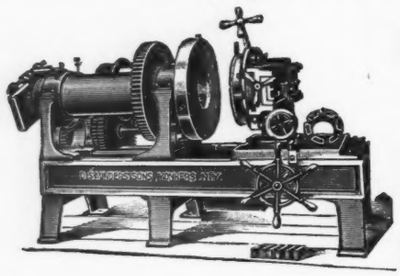
Trimont Mfg. Co., - Roxbury, Mass.

SOLD BY ALL JOBBERS.



As nearly perfect as can be made

is what we claim for our



Pipe Threading and Cutting Machinery.

These machines are the result of forty years' practical experience in this line of manufacture, and are unsurpassed for efficiency of operation and quality of workmanship.

May we send you our catalogue?

D. Saunders' Sons, Yonkers, N. Y.

BURR KEYSEATERS

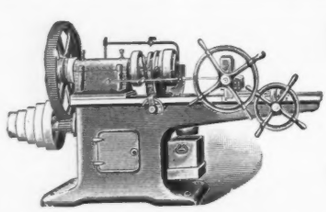
Will Pay for Itself Every Year.

Saves time and lots of money. Complete with Cutters. Satisfaction Guaranteed.

$40.00

Catalogue Free.

JOHN T. BURR & SON,
84 South Sixth St., Brooklyn, N. Y.



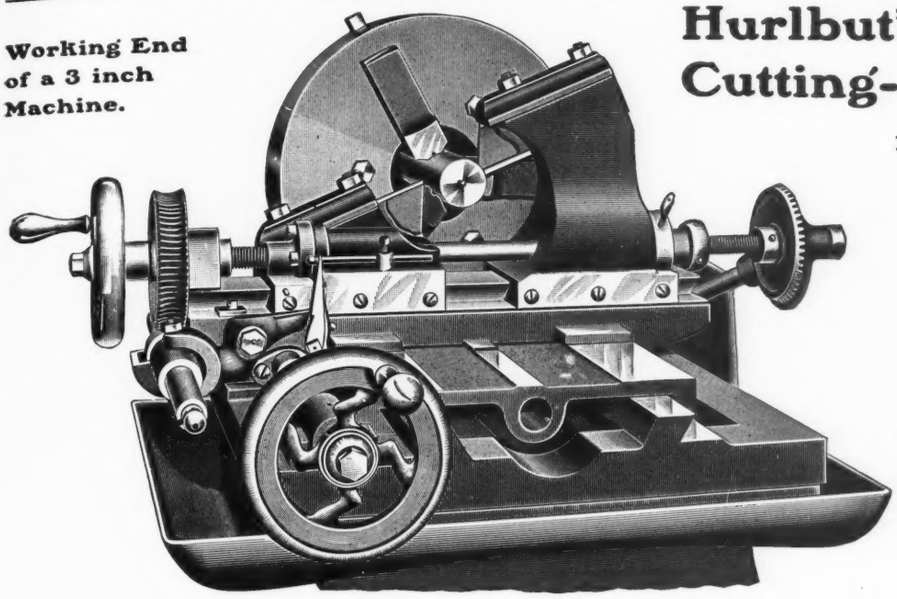
Bolt Cutters and Nut Tappers.

ALL SIZES.

Single and Multiple Spindle, either belt or motor driven.

The Reliance Machine and Tool Company,
Cleveland, Ohio.

Working End of a 3 inch Machine.



Hurlbut's Patent Cutting-off Machine

Made in

2 in., 3 in., 4 in., 5 in., 6 in., 8 in. and 10 in. sizes.

CIRCULARS ON APPLICATION.

Hurlbut-Rogers Machine Co.

So. Sudbury, Mass., U. S. A.

The Genuine Armstrong Adjustable Stocks and Dies

for threading pipe. Universally acknowledged to be the best on the market. Will take pipe from ⅛ to 1¼ inches cutting right and left.

Send for catalogue.

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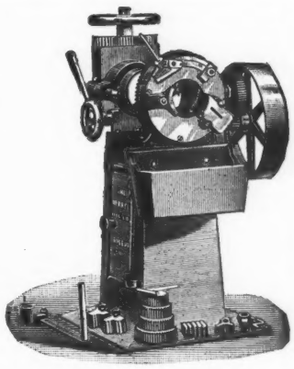
Pipe Threading and Cutting Machinery

OUR Combined Hand and Power Pipe Threading and Cutting Machine will do better work than any other combined machine on the market. Rapid, durable and convenient. Wide range of work. All sizes described in catalog No. 5.



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NEW PLANTS. OLD PLANTS MODERNIZED.

WIRE MILLS. CHAIN FACTORIES.

SEWER PIPE FACTORIES.

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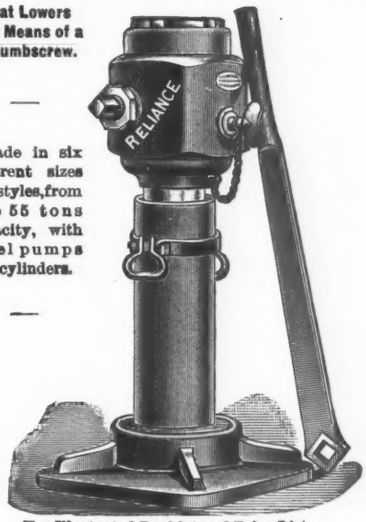
That Lowers By Means of a Thumbscrew.

Made in six different sizes and styles, from 8 to 55 tons capacity, with steel pumps and cylinders.



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HALL'S CAST IRON PIPE CUTTERS.
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WALWORTH HEAVY VISE, 1-8 TO 6 IN.
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HALL'S TAPPING MACHINES FOR STREET MAINS
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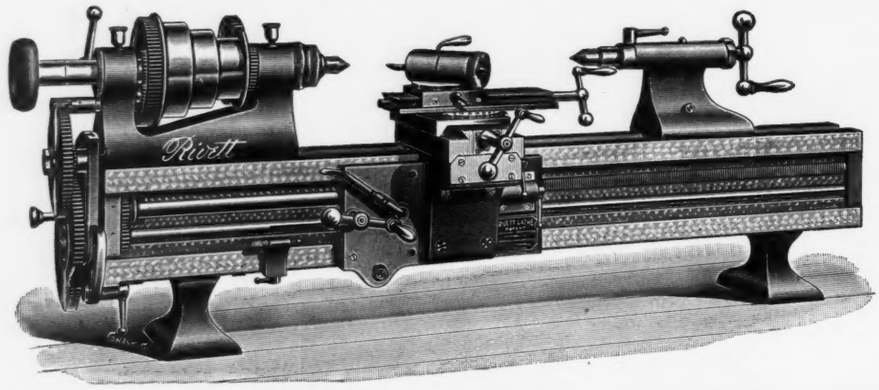
TAPS, REAMERS AND DRILLS.

WRITE FOR BLUE BOOK "H" ILLUSTRATING OUR FULL LINE OF TOOLS.

The "Rivett" Precision Lathe



Is just what the name implies, a tool for handling that class of work which requires the highest degree of accuracy. No factory no matter what size is complete without it.

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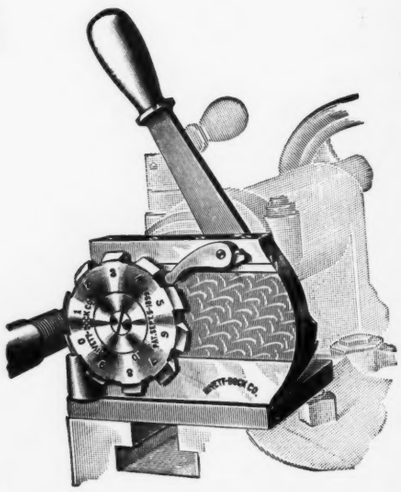
Faneuil Watch Tool Co., Brighton, Boston, Mass.

The Rivett-Dock Threading Tool

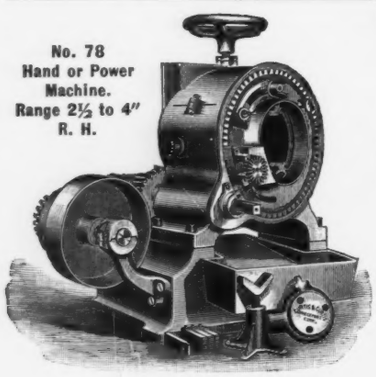
Is a paying investment because with ordinary labor it will produce more and better work in one week than a skilled machinist could turn out in 4 to 6 weeks using a single pointed tool. The tool once set, no further adjustment is necessary to thread any number of screws accurately and in absolute duplication. An innovation in lathe tools that will return its cost within thirty days steady use.

Let us send you full description and partial list of users.

The Rivett-Dock Co., Brighton, Boston, Mass.



No. 78
Hand or Power
Machine.
Range 2½ to 4"
R. H.



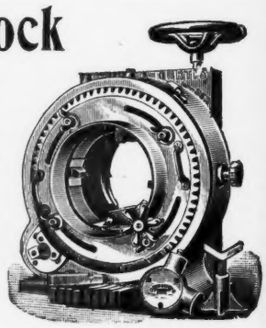
The Forbes Patent Die Stock

For Threading and Cutting off Pipe

The most convenient, durable and reliable tool of its class on the market. Saves its cost in time and labor in a few weeks. Complete in itself, easily portable and especially useful for work in confined places. Arranged for hand or power.

CATALOG FOR DETAILS.

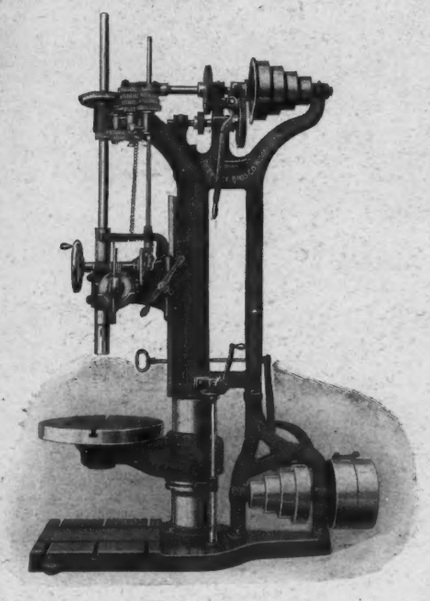
The Curtis & Curtis Co., 8 GARDEN STREET, BRIDGEPORT, CONN., U.S.A.



No. 56 Hand Machine.
Range 2½ to 6" R. H.

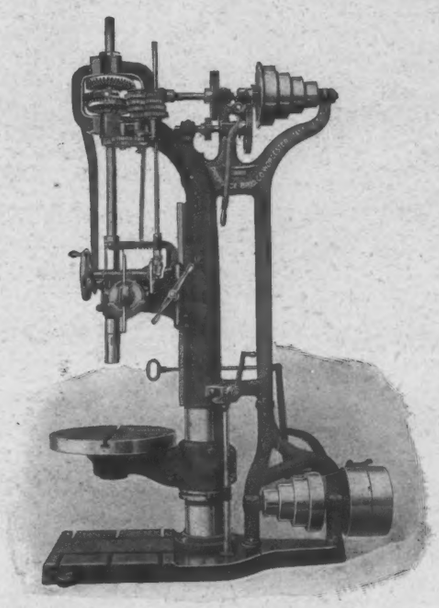
GO AHEAD MOTION
AND
STOP MOTION

Our new model Vertical Drilling Machines—24, 26, 28, 30, 36, 42 and 50-inch swing, have gear feeds.



Good 30 Years Ago

Today 30 Years Better



With Tapping Attachment

Large worm gears, running in oil pockets. Driving bevel gears with teeth planed to give contact entire length. A quick approach and return movement to spindle by same lever that throws in the power feed.

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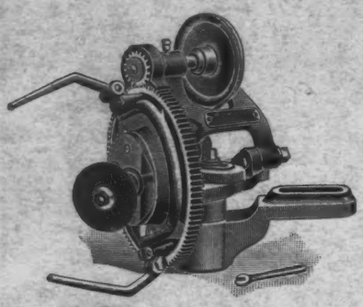
WORCESTER, MASS., U. S. A.

Builders of Vertical, Horizontal, Radial and Multi-Spindle Drilling Machines, Engine Lathes, 14 to 32 in. Swing, Belt or Electrically Driven

No. 1 "Simplex" Lathe Center Grinder

Is designed for quickly and accurately grinding centers of lathes. It is clamped to the carriage of the lathe in place of the tool post, and driven from the face plate by two arms inserted in the face plate slots. The wheel can be accurately set at the proper angle with center, and an adjustment for height permits its use on any sized lathe.



No. 2 "Simplex Universal" Lathe Center Grinder is a heavy machine, adjustable to grind centers accurately to any angle from 55° to 90° inclusive, and can be used on lathes of American or European patterns. It is not necessary to remove the face plates which is a great advantage in the case of very heavy, slow moving lathes. Strong, durable, efficient tools. Full particulars and catalogs on application.

Diamond Machine Company, Providence, R.I., U.S.A.

Boring and Turning Mills.

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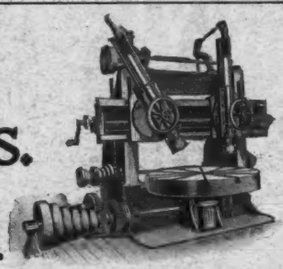

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H. BICKFORD & CO., Lakeport, N.H., U.S.A.

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We do not pretend that the Star Hack Saw is as low in price as most other brands in the market, but with cutting qualities considered, we do claim that it is more than 100 per cent. the cheapest. Some dealers and consumers have learned from experience that steel, teeth and holes do not constitute a Hack Saw.

Star Saws are sold by ★ prominent dealers everywhere. Look for the ★ which is stamped on each genuine blade.

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28 Warren Street - NEW YORK, N. Y.

GEARS 42" FACE ARE NOT TOO WIDE FOR US
GLEASON TOOL CO. ROCHESTER, N.Y.

GEAR PLANERS STAND A FEED UP TO THE LIMIT OF THE BEST TOOL STEEL

THE PIONEER HOUSE IN ABRASIVES THE TANITE CO. STROUDSBURG, PA.

Oil Tube Drills

Just the thing for quick work or drilling of deep holes. Made in all sizes.

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Cleveland. New York. Chicago.

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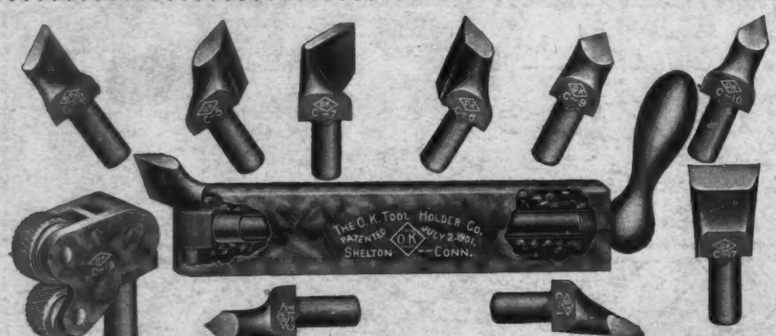

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